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The Choice of a Dynamo. ON another page we give to our readers a thoughtful article by Prof. E. P. Roberts on the various qualities that should be subjected to critical examination in choosing a dynamo for various purposes. There are those who still buy electrical machinery solely on the representations of glib-tongued agents, but the day is fast coming when intending purchasers cannot be deluded by the maker's name plate or by a specious catalogue of imaginary virtues, and Prof. Roberts is quite up with the spirit of the times in his suggestions. Not only may they be well taken to heart by business men, but they furnish a capital basis for the critical examination of a new machine even by experts. To be sure, in these days the majority of standard machines are of good quality and reliable, but "black sheep" will now and then turn up and must be watched for. Unfortunately many faults of construction are hidden in the finished machine, but the more glaring ones can be detected without much difficulty if the machine be subjected to a searching inspection.

Accumulators Abroad. A PAPER from a European correspondent elsewhere in our columns gives a good deal of interesting information about the storage battery and its application as seen across the water, and one feature of the subject is specially well worth noticing—that far more is being done there than in this country as regards the use of accumulators in central stations. For a single storage battery to be employed in twenty central stations is a remarkable record considering the competition that is constantly met, and shows very effectively that the accumulator has a place in modern electrical practice. In light central station work it is at its very best as regards efficiency and durability, and the growth of European practice in this direction is a practical demonstration of the above theoretical statement. In its proper place and used carefully, the storage battery is capable of giving very excellent results. It is only when outrageous demands are made upon it, or it is carelessly handled, that trouble is met. Business in this country has been, until within the last year, so tangled in patent complications that there has been a lack of commercial confidence that has been more serious even than any electrical doubts, and it is to be hoped that in the future the accumulator will be given the chance that it has not had in the past, for under favorable circumstances it may be very effectively employed.

An Electrical Congress for 1893. A LETTER from Prof. H. S. Carhart published in another column calls attention to the steps that have been taken for securing an international electrical congress at the time of the World's Fair in 1893. The time will be a very appropriate one, not only on account of the importance of the foreign interests on that occasion, but intrinsically because of the great need of such a gathering. The Paris congress of 1881 accomplished a great work in systematizing electrical affairs; since then, in spite of the enormous development that has taken place, nothing of anywhere near the same importance has been accomplished. The congress just closed at Frankfort was peculiarly disappointing, and indeed it lacked a thoroughly international character. In 1893 it is to be hoped that a representative gathering of the scientific electricians of all nations can be brought together for the purpose of going over the whole field of the applications of electricity and systematizing nomenclature and practice so far as possible. There is much to be done, and nothing but a concerted effort will ever be able to accomplish it. Most important it is that the United States government should enter actively into the plan, for without its assistance it is very difficult to obtain results that will be generally sanctioned abroad. There will be a splendid chance for carrying out of work of great scientific and practical importance, and the opportunity should not be neglected. It is especially important, too, to begin operations at once and thus get the matter well in hand so that no hurried work at the last moment will mar the success of what ought to be an international meeting of surpassing interest.

The Subways Again. THE subway company and the electric light companies have apparently just started in on the semi-annual fight that seems an inseparable portion of the electric lighting industry in New York. We have commented so many times on the rapacity of the subway company and the machinations that have so long been in progress to hinder high tension electric lighting that further remarks seem almost useless; still we cannot refrain from again calling public attention to the persistent repression of electrical development at the hands of the company in question. The prices charged for subway accommodations are so great as to be practically prohibitive in some sections of the city, and exceedingly burdensome in all; to render the case all the more exasperating it is perfectly well known that thoroughly well constructed subways could be put down complete for two or three times the price charged for a single year's rent; in fact there are several responsible companies that would be very glad of the chance to show what may be done in this direction. It is hard to find a worse case of combined political and commercial intrigue. If New York is ever to become an electrical centre, by some means or other the perennial subway difficulty will have to be settled. Like other reforms no small difficulties are in the way, and it may be a long time before anything of account will be accomplished, but while the question of municipal reform is being continually agitated this particular branch of it is worthy the attention of those who profess to be interested in purifying politics and securing proper administration of the laws.

Electricity vs. Kerosene. SOME TIME ago we published a brief paper in which it was demonstrated that under favorable circumstances the electric light could compete not only with gas but with the kerosene lamp. The statement seemed at first sight an extraordinary one, but a little investigation showed that there were good and sufficient reasons for the observed fact, and this even at American prices for oil. Elsewhere the difference in cost may be yet more striking, and a fine example of a case perhaps exceptionally favorable to electricity may be found in the city of Madrid. An article in one of the Spanish papers recently contained a long review of the facts with details as to cost. It appears that in the city mentioned the cost of oil is as high as 20 cents per pint, while gas costs about $2.37 per thousand cubic feet. Figuring out the cost in Madrid of an oil lamp of say 10 c. p. burning five hours per day, it appears that the total expense amounts to about $1.06 per month. There are plenty of places both in this country and abroad where the electric light companies would be glad to furnish even a 16-c. p. light at that rate. Low candle power lamps, however, are comparatively little used in this country. By turning to the London experience we find that the 10-c. p. electric lamp could be furnished at current rates at about 75 cents per month. In the ordinary practical use of kerosene lamps where a number are kept lighted throughout the evening, as was the case in he paper previously mentioned, the result would be even more in favor of electricity, particularly if supplied by meter, for economy can be practiced with electric lighting better even than with gas. From this bit of foreign experience it becomes evident enough that there are many localities where the electric light could be introduced and prove a commercial success when compared with oil lamps even on the score of economy. At the prices ruling for petroleum oil and gas in Madrid there can be no question as to the outcome of the comparison.

The Genesis of the Electric Motor. WE publish elsewhere a brief note communicated to one of the foreign papers concerning the important discovery of the reversibility of the dynamo, that great principle that has made the modern development of electric power possible. Whenever one takes up from an historical point of view the story of a great discovery or invention it is almost always found that while one man at a particular time may be said to have developed the idea and brought it into working form, others long before him have hinted at it more or less directly, have stated the principle, and have even gone so far as to carry on experiments, that remain almost forgotten until the delving investigator brings them from their seclusion. Such was the case notably with the telegraph and the telephone; the former had been worked at on various principles and by various men for a long time before Morse and Wheatstone, following up the work of Schilling, Henry and others, evolved a simple practical instrument for every day use. In the case of the telephone it was 30 years after the crude apparatus of Reis, and nearly a decade after the exhibition of his successful but imperfectly comprehended transmission of articulate speech, that Alexander Graham Bell brought the modern telephone into available form. So with the electric motor, more than 20 years before the famous experiments of 1878, Jacobi had stated in outspoken terms that the dynamo was reversible, and five years before the work of Gramme, Pfaundler had shown experimentally that the electric motor could be used for generating continuous currents. Siemens and others had labored along the same line, but apparently the world requires years to recognize and assimilate ideas. A single individual here and there may appreciate their importance, but nothing of value results until the slow consciousness of mankind in general is ready to receive the announcement of a great discovery. If further evidence of this truth be needed, no better example could be found than that of Clerk Maxwell's beautiful statement of the fundamental theorem of the magnetic circuit, which laid dormant for a decade before it was quickened into active life by the investigations of Hopkinson and others now nearly ten years since.

The Drehstrom Motor. WE publish elsewhere this week a paper read before the International Congress of Electricians at Frankfort by Mr. Ludwig Gutmann, who is well known to American electricians as a successful and persistent experimenter on alternating current apparatus. The paper is of special interest not only on account of the nature of its contents, but as being the only American paper presented by the author in person. In discussing the rotary current motor Mr. Gutmann casts a good deal of light on the difficulties that stand in the way of the development of any alternating current motor system that requires especial generators and lines peculiar to itself. If it were possible to obtain a motor which should operate with fair efficiency on any alternating circuit it would undoubtedly come at once into widespread use, provided only that it were able to start itself at a reasonable load. If some convenient means could be found of making the ordinary synchronizing motor self-starting it would find a wide field for its application. When, however, a motor system is such as requires special circuits and a special power equipment, its applicability to ordinary service is very much diminished, and as a rule where lines have to be especially arranged for the supply of power, except in so far as long distances are concerned, the ordinary continuous current motor, the properties of which have been well tried, is likely to hold its own. The same commercial causes that hindered the development of the really successful and efficient Tesla motor will prevent the ready introduction of the multiple current motor, which is practically the same in principle. Where large power units are to be supplied at long distances, the chance of these special machines in the electrical struggle that goes on in following the general law of the survival of the fittest is somewhat bettered. The triple current motor as developed by Von Dolivo-Dobrowolsky is a very ingenious machine and its application to the Lauffen-Frankfort line has brought it into deserved prominence; nevertheless, it yet remains to be shown that it is practically any more efficient than the Tesla motor that has been known for several years in this country. The latter under favorable circumstances can be made very economical of power, and the difficulties it has had to face are not electrical so much as commercial. The need to-day, however, is not for an ideally efficient system which can be operated only under special conditions, but for a workable small machine that can be operated on any alternating current lighting system and will start under load. Let such a one be supplied—as has been promised by at least one well known American inventor—and the Drehstrom system will discover that it is not filling any long felt want in the electrical transmission of power.

Latest Foreign Electrical News.

(By cable from our Own Correspondent.)

London, Oct. 12, 1891.—Mr. C. E. L. Brown, who has recently left the Oerlikon company at Zurich, has established himself at Baden, Switzerland, and is beginning preparations there to continue the electrical work by which he is already so will known.

Municipal lighting in this country is progressing steadily, and the Manchester City Council, of whose plans I have previously told you something, has now gotten so far as to select a site for the great central station to be erected for the electric lighting of that city.

The London General Omnibus Company proposes using electric hand lamps and is making preparations to look into the matter at once, in fact it has gone so far as to invite tenders from various electrical companies.

ELECTRICAL WORLD PORTRAITS.—NO. XXIX.

MR. C. E. L. BROWN.

Through his intimate connection with the Oerlikon Works, and more lately through his special labors in promoting the Lauffen-Frankfort transmission of power, the name of the subject of this sketch has become very familiar to the electrical world. Charles Eugene Lancelot Brown was born in Winterthur, Switzerland, in 1863; his mother was Swiss and his father was well known as a constructing engineer of great skill, especially in the line of steam engine design. Young Brown received his education in the excellent gymnasium and technical school in his native town. After completing his course in this institution he studied for a year in Bürgin's shops in Basle and afterward began his career as an electrical engineer, commencing with the construction of a small dynamo in the electrical works in Winterthur. In 1884 he was engaged by the Oerlikon company and within two years thereafter became director of the electrical department of this famous firm. His name was first made familiar to the public through his connection with the transmission of power plant at Solothurm when he was barely 23 years old. In that installation he successfully demonstrated both his own ability and the possibility of the successful long distance transmission of power. This feat gave him a considerable reputation and at the same time gave a powerful impetus to that particular class of work on the continent. In 1887 he was engaged in important work in Luzerne, and in 1888 he continued his work on the transmission of power, developing some new designs in dynamos and motors, especially a new four-pole type for which he received the only grand prize for dynamo construction at the Paris exhibition of 1889. After this he engaged in the transmission of power at Cassell, where by means of alternating currents he transmitted 200 h. p. over six kilometres, giving a start to the application of alternating currents in a practical way for large powers. The outcome may in part be seen in the Lauffen plant. At that time Mr. Brown began to study the transmission of power with multiphase alternating current motors and high potentials; for this work he devised a special dynamo and type of transformer, both of great usefulness and ingenuity. During all this period he was steadily at work both on the construction of direct and alternating current machines, and among his various devices are the four-pole Oerlikon machine with two exciting coils and a railway motor of similar construction. The great 600 h. p. low potential dynamo for the reduction of aluminium installed at Newhausen is also of Brown's design. His studies in this direction led him to the construction of unipolar machines and to the design of a low potential dynamo of this type, designed to give 3,000 ampères at 10 volts, which perhaps can be counted one of the first practical unipolar dynamos of large size. Very recently Mr. Brown's work has been, aside from the routine duties of the great firm with which he has been connected, turned in the direction of the long distance transmission of power by means of alternating currents, and he has taken an important part in the Lauffen-Frankfort enterprise, designing the very simple and ingenious dynamo used for the supply of power, and also the step-up transformers which are employed at the Lauffen end of the line. Very lately he has left the Oerlikon Works and has established himself in Baden, carrying on the manufacture of electrical machinery, for which his very considerable experience has so well fitted him. He is one of the brightest and best known of the continental electricians, and has a reputation of international importance.

Small Dynamo-Motors.

Some months ago, says *Industries*, when describing the "Infant" dynamo made by Messrs. Austin & Myers, of Leeds, it was sugggested that a small dynamo-motor would be exceedingly useful for experimental and laboratory use. This firm is now putting on the market a small dynamo-motor which can run a 100 volt lamp from a single cell. It takes little trouble to charge one large bichromate cell to give two volts and 50 or 60 ampères, and by means of the small dynamo-motor 100 volts and one ampère or so are available. The machine will also probably come into use for transforming down. For instance, an electroplater may be able to get 100 volts from a supply company; he can then transform down to one or two volts, thus getting his large current. The machine is also arranged to take a direct and give back an alternating current; and this will be exceedingly useful for experimental work.

The Discoverer of Insulation.

BY THOMAS D. LOCKWOOD.

My attention was attracted to your leading article in the issue of The Electrical World of Oct. 10, 1891, referring to insulation, or, more properly speaking, covered wires.

I do not doubt that the first published reference to the *idea* of covering a wire with "continuous and adherent insulating coating" is to be found in the celebrated letter of "C. M." to the *Scot's Magazine*, suggesting an electric telegraph.

This was published Feb. 17, 1753, and contains the following statement: "Lay over the wires from one end to the other, with a thin coat of jeweler's cement.

"This may be done for a trifle of additional expense, and as it *is an electric per se*, will effectually secure any part of the fire from mixing with the atmosphere."

The entire letter may be found in Fahie's "History of Electric Telegraphy," pp. 68–71.

Cavallo appears to have actually covered wires with insulating coatings, as appears from his "Complete Treatise on Electricity," fourth ed., London, 1795, vol. III., pp. 285–296. He says: "A piece of wire being stretched from one side of a room to another. heat it by means of a flame of a candle or of a red hot piece of iron, and as you proceed rub a lump of pitch over the part just heated. When the wire has been thus covered, a slip of linen rag must be put round it, which can be easily made to adhere, and over this rag another coat of melted pitch must be laid with a brush.

C. E. L. BROWN.

"This second layer must be covered with a slip of woolen cloth, which must be fastened by means of a needle and thread. Lastly the cloth must be covered with a thick coat of oil paint. In this manner many pieces of wire, each of about 20 to 30 feet in length, may be prepared, which may afterward be joined together, so as to form one continued metallic communication," etc.

On Dec. 16, 1795, Salvà read a paper before the Academy of Sciences, Barcelona, and in it says: "In the first trials made with a cable of this kind I covered each wire with paper coated with pitch, or some other idio-electric substance, then tying them together, I bound the whole with more paper, which effectually prevented any lateral escape of the electricity."

In the matter of electricity developed from a battery, Sömmering in 1809 took "five wires of silver, or copper, and insulating each with a thick coating of sealing wax bound the whole up into a cable," *vide* "Fahie's History," p. 228.

In the following year he used wires "of brass, or of copper insulated with a coating of gum lac, then wrapped round with a silk thread, and united in a cable."—*Ibid*, p. 235.

Schilling, in 1812, according to Hamel's "Historical Account of the Telegraph," Cooke's Reprint, 1859, devised an electrical conductor for exploding mines which he laid both underground and under sea, calling it a "sub-aqueous galvanic conducting cord (a copper wire insulated with a solution of india rubber and varnish)."

So much for line conductors. Coming now to instruments, I find that Bakewell records that the experiments of Ampère and Arago in following up Oersted's discovery, employed covered wires. "To prevent the communication of the electricity laterally in the folds of the coil, the wire was insulated; by varnish in the first instance, and afterward by winding silk or cotton round it." "Electric Science," Bakewell, London, 1853, p. 87.

On the other hand, Sturgeon, in making his electromagnet, used bare wire, and insulated the iron core. But it seems likely although I do not at present know that it is anywhere recorded, that Schweigger, in 1820 and subsequently, insulated his galvanometer wire, and it is quite certain that Henry, seeing that one of Sturgeon's mistakes was the non-insulation of his wire, did cover the wire of his electromagnet, exhibited in 1828, with silk.

Since writing the above I find that in Young's "Natural Philosophy," London, 1845, a description of Schweigger's galvanometer is given and credited to Schweigger's Journal, 1821, which states that the wire coil "is coated with sealing wax or silk."

The International Congress of Electricians.

BY HENRY S. CARHART.

Several movements have been set on foot, with the object of securing the attendance of foreign electricians of note at the International Congress of Electricians to be held in Chicago in 1893. The American Institute of Electrical Engineers extended an invitation to the Paris Congress in 1889, and to the late Frankfort Congress to be present in Chicago a year from next summer; and the National Electric Light Association, at its recent meeting in Montreal, appointed a committee in the interest of the proposed International Congress of 1893.

The discussion of the subject in the electrical journals discloses the fact that much uncertainty exists, relative to the auspices under which this Congress is to convene. One report from the Frankfort Congress says that the members in attendance were invited to Chicago in 1893 to take part in a conference to be held under the auspices of the American Institute of Electrical Engineers.

While such auspices would undoubtedly command respect abroad, they would not connect the enterprise officially with the World's Columbian Exposition, nor secure the recognition of the government.

It is well known that the World's Congress Auxiliary is an organization authorized and supported by the Exposition Corporation. It "has also been recognized and approved by the government of the United States. Its general announcement has been sent to foreign governments by the Department of State, and an appropriation on account of its expenses has been made by act of Congress."

This organization will provide places of meeting and other appropriate facilities for various conventions or congresses to be held in Chicago at a convenient time in the exposition season of 1893. It has already appointed a number of general committees to organize such congresses, to enlist the interest and co-operation of eminent men at home and abroad, and to secure, if possible, the attendance of the most distinguished representatives of each department of knowledge and activity at its respective congress or convention. These committees are necessarily resident in or near Chicago, but they are expected to procure the co-operation of as many able men as possible, who will constitute an advisory council. The advisory councils are invited to aid the local committees by correspondence and by personal conference as opportunity may offer.

The chairmanship of the local committee on an Electrical Congress has been offered to Prof. Elisha Gray (who has signified his acceptance), and the vice-chairmanship to Col. Clowry. Mr. B. E. Sunny, the chairman of the Montreal Committee, is one of the local committee appointed by the World's Congress Auxiliary; so also is the writer.

Since the movement for an International Congress of Electricians has now been inaugurated by the properly constituted authorities, and under auspices recognized by the World's Fair Directory and by the United States government, it is intended that plans shall be rapidly matured, and that nothing practicable shall be left undone to secure co-operation both at home and abroad. It is probable that some of the committee will visit Europe next season in the interest of the Congress. The only Electrical Congress of great importance thus far held was the Congress at Paris in 1881. Its decisions have been universally accepted, and its influence on the progress of the science of electricity has been plainly apparent ever since. If this supreme opportunity presented by the Word's Fair in 1893 can be rightly aid hold of, the gathering of electricians in congress at that time may prove no less fruitful in results than the one at Paris ten years ago.

The Siemens & Halske Exhibit at Frankfort.

BY CARL HERING.

To the engineer who is occupied with the construction of dynamos and the installation of plants, the large machinery hall is doubtless the most interesting part of the exhibition; together with the adjoining boiler house it forms also the larger part of the total floor space of the whole exhibition. Externally the building is by no means attractive; it is in fact quite unattractive except at night; but what was wanting in beauty on the outside was more than made up by the individual exhibits in the inside. These were, as a rule, well selected and well arranged for inspection, besides being, with perhaps one or two exceptions, displayed with very good taste. There was very little of that which we Americans would call loud or silly display, or what we fear the Europeans might call American display.

The large centre area of the building, under the dome, was occupied by the Helios company, and was illustrated in the last number of THE ELECTRICAL WORLD. The whole of one end of the building was occupied by the working machinery of the firm of Siemens & Halske, and is shown in the adjoining illustration. The whole of the other end was occupied by the Schuckert company. Together they occupied more than half of Machinery Hall. These three large companies, and the Allgemeine Elektricitäts Gesellschaft (whose only exhibit was perhaps the most novel if not the most interesting, namely, the Lauffen-Frankfort transmission of power) are the largest and most important in Germany. Between them they occupy the larger part of the whole exhibition. Of these the old and worldwide known firm of Siemens & Halske, who are the pioneers in Germany, had by far the largest exhibit. Besides the large exhibit shown in the cut, they had large exhibits in other buildings, as in that for scientific apparatus, railroad signals, electric railroads, telephones, galvanoplastics, cables, accumulators, etc.; in fact, there was scarcely a branch in which they did not exhibit, and creditably, too. Their own catalogue of their exhibits was a volume of 150 pages. But creditable as most of their exhibits were, we were not led to change our opinion that the American system of putting all one's strength into one branch, and in fact one specialty in that branch, is the better system. The customs of the two countries are, however, different.

The adjoining illustration shows, on the right, one of their "units" for continuous current central stations, and it is the largest one they build; it is this type which is used in the Berlin central stations. Its general construction is already well known and need therefore not be given here. Its output at 65 revolutions is 330 kilowatts, and at 100 revolutions 600 kilowatts; it has 10 stationary field magnets; the armature, which revolves outside of the magnets, has an outside diameter of 3 metres, nearly 10 feet. The outside windings of the Gramme ring armature form the commutator, and we believe it stands alone as the only dynamo which has a 10-foot commutator. The linear velocity of the wire is, of course, great as compared with the speed of revolution, which is doubtless the object of this odd construction; but whether this justifies the otherwise complicated construction is perhaps a question. Most of this complication seen in the cut is due to the fact that these ten sets, of three brushes each, must be capable of being raised, lowered and moved simultaneously. The brushes in the pit can neither be seen nor handled separately. This type of machine seems to meet with favor, as the total output of those in use is 17,700 kilowatts.

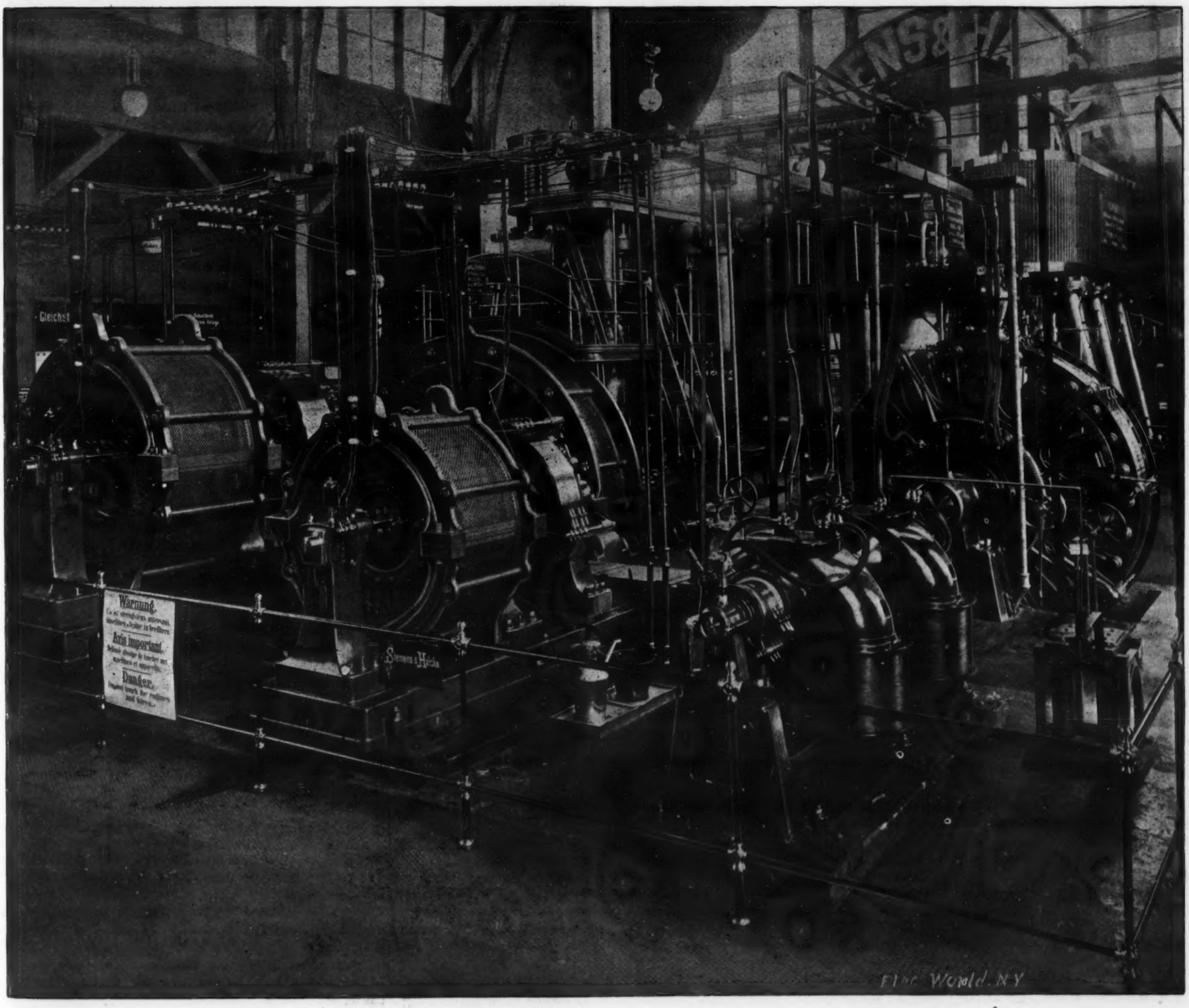
It is coupled directly to a magnificent specimen of a triple expansion 500 effective h. p. engine of the firm of G. Kuhn, of Stuttgart. As a quietly running engine it excels any of those exhibited. Standing close to it, with closed eyes, one could hardly tell it was running. This speaks well for its construction; as to its efficiency, we understand it is equally creditable. The other large dynamo, seen to the right of this, is one of their largest alternating current machines of 330 kilowatts (maximum) at 100 revolutions, generating 2,000 volts. Its fixed armature of 4.6 metres outside diameter has 60 coils corresponding to the 60 radial revolving magnets. Its construction is similar to one of their oldest types, and is well known. There seems to have been some trouble with this machine, as it was rumored that it was not run loaded at this exhibition.

The cut furthermore shows a set of their transformers of the motor-dynamo type. One is for converting continuous currents of high into low potential, or the reverse, and consists simply of a motor and dynamo coupled together. Another is for converting alternating into continuous currents and chiefly for charging accumulators with alternating currents, and the third for the reverse operation. Each of them consists of a motor and a dynamo coupled together. The one for converting an alternating into a continuous current, having an alternating current motor of the synchronizing type, must first be started, which may be done by using the continuous current dynamo as a motor first. The application of such a transformer is therefore quite limited. There is little to be described about these, as they are very much like the single dynamos except that the bearings and the whole framework are much lighter, as there is no side strain to the shafts. These transformers give a good opportunity for comparing the relative sizes of a continuous current and an alternating current machine of the same output.

Along one side of this exhibit is a long row of their standard continuous current machines from 80 to 1½ kilowatts. They are of what is sometimes termed "type supérieur," and resemble the Thomson-Houston motor type, or the Edison with the armature at the top. In the larger ones the maximum linear velocity used is 14 metres per second (46 ft.), and in the smaller ones 20 metres (66 ft.). One of the characteristic features is that the commutator is composed of ⌐-shaped bars of iron (or steel) insulated on the inside and between the bars by an air space. This may run better, but it has the disadvantage that the air spaces may fill up with conducting dirt or fragments of the brushes while running.

On the left hand side along the wall are the switchboards for the various installations, some of which will be referred to in a subsequent description. It may be said here that they appear to prefer marble for the base plate of switchboards. For large heavy switches the slabs are quite thick, up to about two inches. They claim that slate is too apt to contain conducting strata.

Among their other exhibits in this group are parts of



GENERAL VIEW OF THE SIEMENS & HALSKE EXHIBIT AT THE FRANKFORT EXPOSITION.

dynamos showing their construction, and a three phase alternating current dynamo and motor of a new construction, but not running. In the corner is the dark room, in which were exhibited the very interesting experiments with a 20,000-volt alternating current, described in a previous communication.

Storage Batteries in Central Stations.

BY F. C. PERKINS.

The plant shown in the accompanying illustration is on exhibition in Machinery Hall at the International Electrical Exposition, Frankfort-on-the-Main. It is used in connection with the Siemens & Halske exhibit and is complete in every respect. This battery consists of 168 cells connected in two sets of 84 cells in series, the two sets being connected in parallel. The normal voltage of each cell is 1.85 volts, the working potential being 150 volts. When the battery is discharged at the rate of 413 ampères, the capacity is 1,380 ampère hours, *i. e.*, it is discharged in about three and one-half hours. The capacity is raised to 1,980 ampère hours if it is allowed a longer time to discharge and at the rate of 237 ampères. The charging current used is 345 ampères for each series, making 690 ampères for both sets. It is charged in four hours if the discharge has been made in three and one-half hours. Each cell has 30 positive and 31 negative plates, with a surface 18 decimetres square for each plate.

The life of this battery is said to be great. Two plates, a positive and a negative, are on exhibition, which have been in use nearly eight years in the battery at Mr. Tudor's residence near Rosport, Luxemburg. The plates are formed after the Planté method, and Dr. Schmidt, the chemist of the company, claims that, after one year's work, if the active material has all fallen down, the plate has become so well formed by that time that it works equally well without the active material. This battery was manufactured by the Aktien Gesellschaft of Hagen, W., and this company has eight other plants in the Exposition.

This battery is connected in parallel with the 500-h. p. direct current dynamo of Siemens & Halske, which is seen on the right in the background in the view, shown on page 285, of Siemens & Halske's exhibit. It is a 10-pole machine, with a Gramme armature over three metres in diameter, and gives an output of 600,000 watts at 100 revolutions. The potential is 150 volts. The armature shaft of the dynamo is directly connected to a triple expansion condensing engine of the marine type, built by G. Kuhn, of Stuttgart-Berg. This engine develops 500 h. p. at 100 revolutions and 600 h. p. at 120 revolutions.

When this dynamo is not in use the battery supplies energy for the entire plant, *i. e.*, for the overhead street railway, the incandescent and arc lights, direct and alternating, and direct and alternating motors. The battery does this in the following manner:

(1) For the street railway work requiring 300 volts when the battery gives 150 volts. In the view at the right will be seen the "direct-direct current transformer." This machine is used for transforming a low pressure continuous current into a higher pressure continuous current or vice versa. It is built in the form of a double machine. On the main shaft are mounted two armatures, each surrounded by its own excited field, one being used as a motor and the other as a generator. In this case the current from the battery or large generator is delivered to the motor armature at a potential of 150 volts, and a current obtained from the generator armature at 300 volts for the overhead railway work. In this way the battery may operate the railway line, and does so morning and evening when the large generator is not running. The capacity of this transformer is 60,000 watts.

(2) For alternating work requiring 2,000 volts when the battery gives only 150 volts direct current. In the central part of view may be seen the wechselstrom—gleichstrom transformer (alternating current—direct current transformer). It is often very desirable to use accumulators in combination with alternating current stations, and as it is impossible to charge them with an alternating current, this combination of an alternating current machine and a continuous one is used. The two armatures are mounted on a common axis, and in this way the superfluous power of the engine can be used in operating the transformer for charging the accumulators or vice versa; the storage battery may be used to furnish continuous current to the transformer at 150 volts and obtain from the transformer an alternating current of 2,000 volts. The capacity of this machine is 200 h. p.

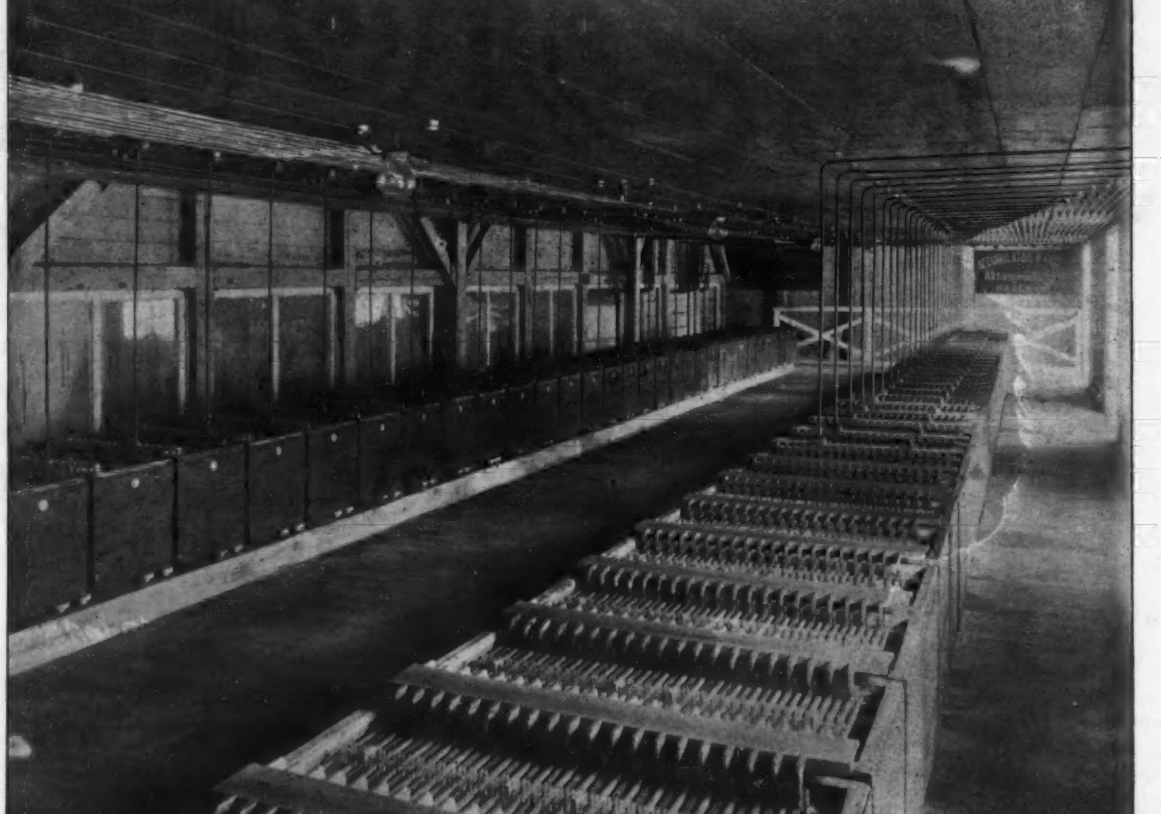
If the battery has been discharged and only the large alternating machine is running, this current at 2,000 volts is used to drive the transformer, which in its turn delivers a current of 150 volts to the battery. Automatic devices are used to throw out the battery when discharged.

The large alternating current dynamo may be seen in the background of the view to the left. It is connected directly to a 450 h. p. vertical engine built by the Machinen Fabrik Buckau, of Magdeburg. The nominal speed is 100 revolutions. The field of the alternator is excited by a separate generator coupled directly to a 60 h. p. vertical engine. The efficiency of the apparatus described will probably not be known definitely until after the report of the commission.

An alternating current transformer is on exhibition which transforms from 2,000 volts to 20,000 volts, *i. e.*, a ratio of 1 to 10. It is used for experimenting with high tension currents, and a battery of lamps numbering 400 are connected in series with one another for this purpose.

The committee is at work making the tests of apparatus in the exposition and a report from it will be of much interest.

FRANKFORT-ON-MAIN, Sept. 25, 1891.



STORAGE BATTERY EXHIBIT AT THE FRANKFORT EXPOSITION SHOWING THE APPLICATION OF SECONDARY CELLS TO CENTRAL STATION LIGHTING.

The Cost of Electric Traction as Shown by the Monthly Statement of the West End Company.

The August figures of the operation of the West End Street Railway Company have just been compiled by the auditor and are here given in full as furnished by the company for publication:

AUGUST STATEMENT.

	Total.	Electric.	Horse.
Gross receipts	$528,720	$136,246	$392,474
General expenses	24,187	6,027	18,159
Track and car expenses	168,242	43,620	124,622
Motive power	138,981	25,630	113,351
Total operating expenses	331,410	75,277	256,133
Net earnings	197,309	60,968	136,340
Miles run	1,460,212	363,836	1,096,376
Ratio mileage	100	24.92	75.08
Per cent. operating expen.	62.68	57.13	64.52
Earnings per mile run	36.21	37.45	35.80
Expenses per mile run:			
Motive power	09.52	07.04	10.33
Car repairs	00.41	01.57	00.03
Damages	00.13	00.23	00.10
Conductors and drivers	07.78	06.85	08.10
Other expenses	04.86	05.00	04.81
Total ex. per mile run	22.70	20.69	23.37
Net earnings per mile run.	13.51	16.76	12.43

The West End report for August, says the Boston *News Bureau*, shows by comparison with the previous four monthly reports a single interesting feature: The regularity of the low cost per mile of operating the electric cars. The expense per electric car mile for August was 20.69 cents as compared with 21.75 cents in April, 22.36 in May, 20.37 in June, and 20.48 in July.

The statements in detail for the months of April, May, June and July may be found in THE ELECTRICAL WORLD of July 25, Aug. 1 and Sept. 5.

The Copper Supplies of the World.

Statistics just compiled show that in 1887 the total copper supplies of the world were estimated at 223,078 tons; in the following year they reached 258,026 tons; and in 1889, notwithstanding the depression which followed the collapse in copper speculation, the production of the metal further increased to 261,650 tons. In 1890 there was a still further jump to 269,685 tons. The most striking expansion has been witnessed in the United States, where the production rose from 25,010 tons in 1880 to 116,325 tons in 1890. During the same period the production of copper in Japan increased from 3,900 tons to 15,000 tons, and that of Spain and Portugal from 36,313 tons in 1880 to 52,335 tons in 1890. The Peninsula reached high water in copper production in 1888, when there was an aggregate of 56,450 tons. In Chili the production has greatly diminished. In 1880 the production of copper in that country reached a total of 42,916 tons, whereas last year it amounted to only 26,120 tons.

Additional Facts Concerning the History of the Electric Transmission of Power.*

BY A. M. TANNER.

Now that the subject of the history of the electric transmission of force is being extensively discussed, it becomes of interest to bring to light and general notice the following additional facts concerning the matter:

In the "Mélanges Physiques et Chimiques," of the St. Petersburg Academy of Sciences for the year 1870, vol. VIII., Prof. Jacobi says: "In my prior work I repeatedly made the experiment of locating such an electromagnetic motor in the plane of the magnetic meridian, and obtaining a magneto-electric current by mechanically turning the apparatus. In article V. of my 'Mémoire sur la Théorie des Machines Electro-Magnetiques,' published in the year 1850, I stated that every electromagnetic machine could be worked as a magneto-electric machine, and *vice versa*.'

In Poggendorff's "Annalen der Physik" for 1851, vol. LXXXIV., p. 187, Dr. Sinsteden, in describing experiments with a magneto-electric machine, says: "These magneto-electric currents thus increased to an enormous strength can also be utilized in force machines (electric motors) in place of the costly hydro-electric currents, over which they would have the important advantage of causing no running expenses by reason of he consumption of zinc and acids."

In the same work, vol. XVIII., A. D. 1883, Von Waltenhofen states that Prof. Pfaundler, of Innsbruck, experimented with the Kravogl electric motor exhibited at the Paris Exposition of 1867, and found that it could be used for generating continuous electric currents.

Prof. von Waltenhofen bases this statement upon a letter received by him from Prof. Pfaundler, dated Nov. 9, 1867, which says:

"I am sorry that I cannot return and see the motor (Kravogl) again. I would have liked very much to make experiments with the same by using it reversibly, and thus producing electric currents and the electric light by mechanical work. It is my intention to apply a strong force for turning the wheel in an opposite direction from the rotation affected by the battery, and then gradually cut the latter out of circuit. This idea of Siemens can surely be also applied to the Kravogl motor?"

In another letter of Prof. Pfaundler, dated Feb. 11, 1870, it is stated that: "The Siemens principle can, in fact, be applied to the Kravogl motor. When the same is driven by hand (without a battery), a current is produced of the strength given by a Bunsen element."

A French patent of Cazal, dated May 25, 1864, No. 63,155, describes and illustrates an electric railway system in which one or more magneto-electric machines are operated by hydraulic or wind motors, and the current generated is conveyed to a rotary car motor by wires and the track rails upon which the car runs. In this patent of Cazal we have another instance of the utilization of natural forces for driving magneto-electric machines, and the conveyance of the electric currents from these machines to distant electric motors.

In view of the citations in the present article, it certainly cannot be held that Gramme made a great discovery when

*From the *Electrical Review* (London).

he ascertained the reversibility of his special dynamo-electric machines, and used two identical machines, one for the generator, and the other as the motor.

The Elements of Practical Electricity *

BY DR. LOUIS BELL.

MAGNETIC EFFECTS OF THE ELECTRIC CURRENT.

We must pass now from the chemical effects of the electric current, interesting as they are, to another quite distinct group of phenomena that involve the fundamental principles of a very large proportion of the modern applications of electricity. These are the very complicated and extraordinary relations that exist between a wire carrying an electric current and magnetism in its various manifestations. The magnet is presumably familiar to you already in its usual simple form of a horseshoe shaped piece of steel with gaudily painted ends, such as is found in the toy shops. Simple as this magnet is, it is capable of taking part in a great many interesting experiments. Of course its general power in picking up iron in almost any form, and imparting its own magnetic properties to iron that is placed in contact with it, is sufficiently well known to you. There is one distinction between magnetic phenomena, however, that it is worth while to mention here before saying anything about the part the electric current plays in modern ideas of the magnet. Procure a little horseshoe magnet and a handful of iron filings. Dipping the magnet in these will result in the formation on the ends or poles of the horseshoe of curious tufts of filings, which are composed, as you will find if you examine them closely, of strings of particles of iron more or less matted together and clinging to each other. On scraping them off the magnet they no longer continue to cohere, but fall apart into an ordinary mass of filings. It seems, therefore, that through the effect of the magnet on the first filings that cling to its poles, as the ends where magnetic action is most manifest are called, these acquire the power of clinging magnetically to others, and these in turn to others, until quite a long chain of filings is formed.

FIG 11.—ELECTROMAGNET CARRYING IRON FILINGS.

The same fact is shown in even a more striking way by dipping the magnet into a handful of fine carpet tacks. After these are removed from the magnet, as in the case of the iron filings, they exhibit scarcely any tendency to cling together, although unquestionably magnetic while in contact with the little horseshoe. If, however, instead of soft iron filings and small tacks, you place a steel knife blade or a large needle across the poles of the magnet you will find that not only is it rendered capable of picking up iron filings while in position across the magnet poles, but it retains this power after it is pulled away. In general soft iron when touched or rubbed with a magnet acquires magnetic properties that last only so long as the contact with the magnet lasts, whereas if steel is employed it becomes permanently magnetized. We shall see later that there is really no distinction between permanent and temporary magnetization, for all iron will acquire a certain permanent magnetic quality if given a chance, but more or less as it is hard or soft.

THE ELECTROMAGNET.

You will need for the experiments about to be described beside what you already have, and what has just been mentioned, only a few feet of insulated copper wire, No. 16 or 18 in size, a piece of thick iron telegraph wire, a cheap pocket compass, and finally a ring of soft iron such as is to be found around any blacksmith's shop. The insulated wire had better be the variety known as magnet wire, which is covered with a double layer of cotton thread. Set up one of your bichromate cells and taking a piece of telegraph wire three or four inches long bend it up into a U shaped form, then wind around the loop 15 or 20 turns of wire and connect the loose ends with the poles of your battery; you will immediately find that the little horseshoe of iron wire has acquired all the properties possessed by your permanent horseshoe magnet; dip it into iron filings and you have the result shown in Fig. 11 quite as if you were working with a permanent magnet instead of a little electromagnet. You have in fact constructed an exceedingly simple form of electromagnet, and perhaps its most striking property can be exhibited by disconnecting one end of the wire from your battery, when the tufts of iron filings will immediately fall off completely if you happen to be working with very soft telegraph wire, almost entirely in any case. On making the circuit again the electromagnet resumes its former properties. The ability thus to render a bit of iron magnetic or non-magnetic simply by making or breaking an electric current in the wire that is wound around it is most valuable for a large number of purposes; it is the fundamental principle that underlies the telegraph, for the wire that is

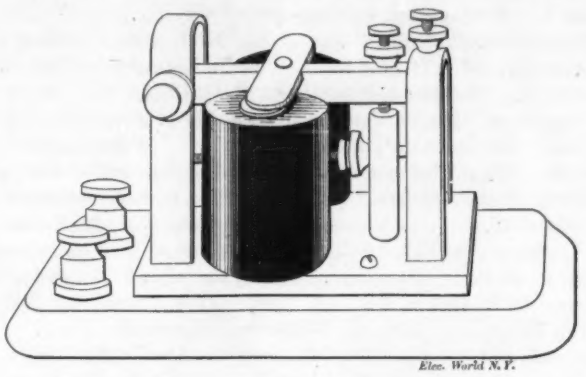


FIG. 12.—A TELEGRAPH SOUNDER.

wound around the soft iron coil of the magnet can be prolonged to any extent, and breaking the circuit anywhere in its length will still rob the core of its magnetic properties. An ordinary telegraph instrument consists merely of a simple U-shaped electromagnet with a bit of soft iron placed where it can be attracted whenever the circuit including magnet is closed, even from a very distant point. In a practical instrument, such as is shown in Fig 12, the U-shaped magnet is turned with its poles uppermost, and the iron bar that forms what is called its armature, in other words, the thing to be attracted, is held away from the poles when the circuit is open by a spiral spring, seen in part just behind the coils, pulling on an arm of the brass lever to which the armature is fastened. The motion of this lever is limited in extent by the screw stops shown in the cut. In spite of these additions the telegraph instrument is in principle just such a little electromagnet as the one you have just made.

On placing a needle or a knife blade across the poles of your electromagnet, you will find that the steel very readily acquires a considerable amount of permanent magnetization. In other words an electromagnet is quite capable of producing, like the ordinary steel magnet, both permanent and temporary magnetism. If the armature of the telegraph instrument were not made of very soft iron, it would soon become permanently magnetized, and would give trouble by sticking to the poles instead of flying up when the current is broken. If you happen to have a small steel screwdriver, it is not a bad idea to take advantage of your apparatus for the purpose of rendering it strongly magnetic, for it is sometimes very convenient to be able to pick up small steel screws on the end of a screwdriver and place them in position without the inconvenience of handling, which is sometimes great where you are attempting to work in narrow quarters or with very small screws. But a horseshoe shaped core is not at all necessary in forming an electromagnet. Make a tube, by rolling up writing paper and gumming it, perhaps half an inch in diameter and three or four inches long; wind around this tube three or four layers of your insulated copper wire, continually winding in the same direction (Fig. 13); connect the loose ends with the terminals of your battery and then through the tube thus wound thrust a straight piece of your iron wire eight or ten inches

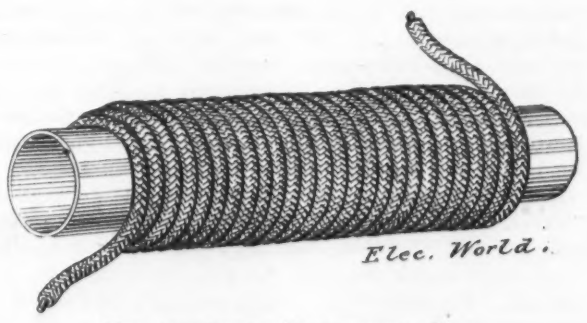


FIG. 13.—SIMPLE MAGNETIZING COIL.

long. On testing this wire with iron filings or in any other convenient way you will find that the ends are rendered strongly magnetic, and if you place a bit of steel inside the coil for a few moments it will acquire permanent magnetism just as if it had been rubbed with the electromagnet you had previously made. In fact, whenever a current is passed through a wire looped about a piece of iron or steel the latter is rendered a magnet; in some way or other the circulating current has affected its properties in a very strong and extraordinary manner. As you are probably aware the common horseshoe magnet has two poles, generally known as north and south, and the north pole is usually marked by a line or cross so that it can be distinguished. To realize the difference between these poles you have only to use a cheap little pocket compass, which consists merely of a magnetized steel needle so balanced that it can readily swing about over a graduated circle, on approaching the north (marked) pole of your horseshoe magnet to the northward pointing end of your compass needle you will notice that the latter is strongly repelled and swings away, whereas if you approach the south end of the needle with your magnet it will be attracted, and you can readily spin the needle around on its axis by giving a circular motion to the magnet. The general law of this action is that like poles, that is north and north or south and south, repel each other and swing away from each other if free to move, while unlike poles, that is south and north, attract each other. You thus have in the compass needle a convenient way of discriminating between the north and the south pole of any magnet you may chance to make, electro or other. Magnetize a needle and you can instantly select either pole by holding one end of it toward the north pole of your compass. Now try the same experiment with the electromagnet you have just formed by placing a long piece of iron wire through your magnetizing coil, and you will find it has strongly marked north and south poles. Or, if you magnetize a needle or screwdriver by thrusting it into the same coil the poles produced will be permanent ones.

RELATION BETWEEN DIRECTION OF CURRENT AND THE POLES FORMED.

Magnetize thus two common needles with the eye of each pointing in the same direction while in the coil, but after magnetizing one and before placing the other within the coil, change the connections at your battery, that is, shift the wire originally connected to the zinc to the copper and the reverse. On magnetizing the second needle and testing both with your compass you will find the eye of one and the point of the other to be north poles. In other words changing the direction of the current by changing the connections at the battery produced a reverse effect on the needle. From this it is evident that the direction in which a given piece of metal will be magnetized, in other words the particular end of it which will be made a north pole, is governed by the direction in which the current may be supposed to flow around the magnetic coil. You may test the same fact by using a long piece of soft iron wire and after testing its poles with a compass needle reverse the current and test again, when the north and south poles will be found to have exchanged places. It is a

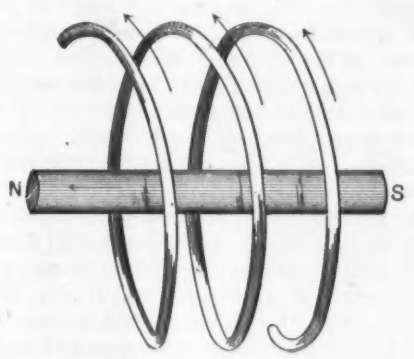


FIG. 14.—RELATION BETWEEN DIRECTION OF CURRENT AND DIRECTION OF MAGNETIZATION.

little difficult to understand just what is meant by the current flowing in a particular direction, but by general agreement the electrical action, whatever it may be, is supposed to flow toward the zinc of a battery and away from the copper or carbon, as the case may be. The zinc pole of a battery, then, is the one toward which we must understand the current to flow outside the battery, while the copper or carbon —according to the sort of cell you are using—is the point from which the flow is supposed to take place. The wire attached to the zinc pole of the battery is usually called the negative pole and is designated by the sign — (*minus*, by name), and that attached to the copper or carbon, the positive pole, usually designated by the sign +, read *plus*. The current always flows away from the latter and to the former. This conventional understanding becomes necessary as soon as we begin to use the current for any practical purpose, or to determine its effect with reference to its direction. That a change in direction produces a change in effect is sufficiently shown from the experiments you have just tried, as well as from the previous one where you attempted the electro-deposition of copper. In that case the positive terminal, or pole as it is more generally called, of the battery was connected to your copper plate, while the mold on which you wished to deposit the copper was connected to the negative pole; if these connections had been reversed you would have got no deposition. Now there is just as distinct relation between the direction of the current and its magnetic action as there was in depositing the copper. Simply stated the relation is this: If you place a needle in your magnetizing coil and look along it from one end, a north or south pole will be produced at that end, according as the current is flowing around it opposite to or in the same direction with the motion of the hands of a clock. If the current, supposed to start from the copper, circulates around the magnetizing coil from right to left as you look at the nearer end of it, a north pole will be formed at that end, if in a reverse direction, a south pole. Fig. 14 shows this relation very nicely. The arrows indicate the direction of the current and the poles marked on the bar within the spiral show the resulting magnetization.

* Continued from THE ELECTRICAL WORLD, Oct. 3, 1891.

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Chronological History of Electricity, Galvanism, Magnetism and the Telegraph, from B. C. 2637 to A. D. 1888.—Part I.

BY P. F. MOTTELAY.

A. D. 1779.——Lord Mahon, afterward third Earl of Stanhope, an Englishman of great ingenuity and fertility in invention and a pupil of Lesage, of Geneva (A. D. 1774), publishes his "Principles of Electricity," in which he explains the effects of the *return stroke* or *lateral shock* of an electrical discharge first observed by Benjamin Wilson—(A. D. 1746).

He imagined that when a large cloud is charged with electricity it displaces much of that fluid from the neighboring stratum of air, and that when the cloud is discharged the electric matter returns into that portion of the atmosphere whence it had previously been driven. According to Lord Cavendish, the theory developed in the above named work is that "A positively electrified body surrounded by air will deposit upon all the particles of that air, which shall come successively into contact with it, a proportional part of its *superabundant* electricity. By which means, the *air* surrounding the body will also become *positively* electrified: that is to say, it will form round that positive body an electrical atmosphere, which will likewise be positive. . . . That the *Density* of all such atmospheres decreases when the distance from the charged body is increased."

Tyndall says (Notes on Lecture VII.) that Lord Mahon fused metals and produced strong physiological effects by the return stroke.

See "Electrical Researches" of Lord Cavendish, pp. XLVI.-XLVII., *Phil. Trans.* for 1787, vol. LXXVII., p. 130; Dr. Thomas Young, "Course of Lectures," London, 1807, vol. I., p. 664; Dr. Thomas Thomson, "History of the Royal Society," London, 1812, p. 449.

A. D. 1779.——Ingen-housz (Johan), distinguished English physician and natural philosopher, native of Breda, publishes in the *Phil. Trans.*, p. 661, an account of the electrical apparatus which is by many believed to have led to the invention of the plate electrical machine, although the same claim has been made in behalf of Jesse Ramsden (A. D. 1768). Dr. Priestley states that Ingen-housz and Ramsden invented it independently of one another. He describes the circular plate of glass as being nine inches in diameter, turning vertically and rubbing against four cushions, which are each an inch and a half long and placed at the opposite ends of the vertical diameter. The conductor is a brass tube bearing two horizontal branches which extend to within about half an inch of the extremity of the glass so that each branch takes off the electricity excited by two of the cushions. (Dr. Thomas Young, "Course of Lectures," vol. II., p. 432.)

The plate machine of Dr. Ingen-housz is illustrated at p. 16 of "Electricity," in the "Library of Useful Knowledge." For other plate machines see, more particularly, Dr. Young's "Course of Lectures," vol. II., p. 431; *Phil. Trans.* 1769, p. 659; Geo. K. Winter's apparatus with ring conductor and peculiar shaped rubbers as well as the great machine at the Royal Polytechnic and that of Mr. Snow Harris, illustrated and described in vol. III., p. 787, "Eng. Ency.—Arts and Sciences," and at pp. 223, 224 of J. H. Pepper's "Cyclopædic Science," London, 1869; "Allg. deutsche Biblioth." B. XXIV., Anh. 4. Abth., p. 549, 1760 (Poggendorff, vol. II., p. 465), relative to the machines of Martin Planta, Ingen-housz and Ramsden; Reiser's plate machine (Lichtenberg and Voight's "Magazin für das Nueste aus der Physik," vol. VII., St. 3, p. 73); Ferdinando Elice, "Sagglio sull' Elettricita," Genoa, 1824 (for two electricities); J. J. Metzger's machine (Elice, "Saggio," second edition, p. 55); Marchese C. Ridolfi, for a description of Novelluccis' plate electrical machine ("Bibl. Italiana," vol. LXIII., p. 268; "Antologia di Firenze," for August, 1824, p. 159); Robert Hare, "Description of an Electrical Plate Machine," London, 1823 (*Phil. Mag.*, vol. LXII., p. 8). See, besides, the machines of Bertholon (rubber in motion) at Lichtenberg, and Voight's "Magazin," vol. I., p. 92 and Rozier XVI., 74; of Brilhac (Rozier, XV., 377), of Saint Julien (Rozier, XXXIII., 367), of Van Marum (Rozier, XXXVIII., 447).

Dr. Ingen-housz also constructed a small magnet, of several laminæ of magnetized steel firmly pressed together, capable of sustaining one hundred and fifty times its own weight. He found that pastes, into the composition of which the powder of the natural magnet entered, were much superior to those made with the powder of iron, the natural magnet having doubtless more coercitive force than iron.

In the *Journal de Physique* for February, 1786, and for May, 1788, are to be found the letters of Dr. Ingen-housz, showing that the vegetation of plants is in no sensible degree either promoted or retarded by common electricity. Reference is also made to his experiments in "Versuche mit Plantzen," Vienna, 1778, in the "Catalogue of the Royal Society," page 313, in "Goth. Mag.," vol. V., III., 13; Rozier, XXXII., 321, XXXIV., 436, XXXV., 81; *Journal de Physique*, vol. XXXV., for 1789. See also, *Journal de Physique*, XLV. (II.), 458; Rozier, XXVIII., 81; M. Nuneberg, "Osservazioni . . . ," Milano, 1776; ("Scelta d'Opuscoli," XVII., 113); Pietro Moscati, "Lettera . . . ," Milano, 1781 ("Opus Scelti," IV., 410); H. B. de Saussure, (*Journal de Physique*, vol. XXV., for 1784); G. da San Martino, "Memoria . . . ," Vicenza, 1785; M. Schwenkenhardt, "Von dem Einfluss . . . ," (Rozier, XXVII., 462; *Journal de Physique*, for 1786, vol. I.); A. M. Vassalli-Gardi, in the "Mem. della Soc. Agr. di Torino," vol. I., for 1786, particularly regarding the experiments of Ingenhousz and Schwenkenhardt, also in the "Giornale Sc. d'una Soc. Fil. di Torino," vol. III.; N. Rouland, "Elec. appliquée aux végétaux" (*Journal de Physique*, 1789-1790); Ingen-housz, Rouland, Dormoy, Bertholon and Derozières, (Rozier, XXXV., 3, 161, 401; XXXVIII., 351, 427, and in *Journal de Physique*, vols. 32, 35, 38); M. Carmoy, on the effects of electricity upon vegetation, in Rozier, XXXIII., 339, *Jour. de Physique*, 1788, vol. XXXIII.); M. Féburier, "Mémoire ser quelques propriétés . . . ;" G. R. Treviranus, "Einfluss . . . ," Kiel, 1800; (Gilbert's *Annalen*, vol. VII., for 1801; "Nordisches Arch. f. Nat. u. Arznein.," 1st Band, 2tes Stück); C. G. Rafn ("Mag. Encyclopédique," No. 19, Ventose an X. p. 370), Paris, 1802; J. P. Gasc, "Mémoire sur l'influence . . . ," Paris, 1823; E. Solly, "On the influence . . . ," London, 1845 ("Journ. of the Hortic. Society," vol. I., part 2); E. Romershausen, "Galv. El. . . . Vegetation," Marburg, 1851; M. Menon, "Influence de l'électricité sur la végétation," and his letters to R. A. F. de Réaumur. Consult, likewise, J. Browning's letter to H. Baker, Dec. 11, 1746. (*Phil. Trans.*, for 1747, vol. XLIV., p. 373); G. Wallerius, "Versuch . . . ," Hamb. and Leipsic, 1754; ("K. Schwed. Akad. Abh.," XVI., 257; "Vetensk Acad. Handl.," 1754); L. T. Kamtz (Kaemtz), "Uber d. Elek . . . ," Nürnberg, 1829; (Schweigger's *Journal f. Chemie u. Physik*, vol. LVI.); Bartolomeo Zanon, "Intorno un punto . . . ," Belluno, 1840; Francesco Zantedeschi "Dell influsso . . . ," Venezia, 1843; ("Mem. dell Instit. Veneto," I., 269); E. F. Wartmann, "Note sur les courants . . . ," Genève, 1850; ("Bibl. Univ. de Genève," for Dec., 1850); T. Pine, "Connection between electricity and vegetation," London, 1840; ("Annals of Electricity," vol. IV., p. 421). For the effects of galvanism on plants, see Giulio in "Bibl. Ital." vol. I., p. 28, also E. J. Schmuck "On the Action of Galvanic Electricity on the *Mimosa Pudica*," and M. Rinklake, "Elektrische versuche an der *Mimosa Pudica*." For an account of M. P. Poggioli's observations on the influence of the *magnetic* rays on vegetation, and the reply of F. Orioli thereto, see vol. I. of the "Nuova collezione d'opuscoli scientifici . . . ," Bologna, 1817."

In the *Philosophical Transactions*, for 1778, pp. 1,027, 1,049, will be found Ingen-housz's paper relating to the then recent invention of Volta's *electrophorus* and to Mr. Henley's experiments. It is said that at about this time (1778), John Jacob Mumenthaler, Swiss mechanic, constructed very effective electrophori and electric machines out of a very peculiar kind of paper. M. F. Vilette also made a paper electrophorus which is alluded to by J. A. Nollet. (See Nollet as to "Experiments, Letters," vol. III., pp. 209, etc.). Consult, besides, Carlo Barletti, "Lettera al Volta . . . ," Milano, 1776; W. L. Krafft, "Tentatem theoriæ . . . ," Petropol, 1778; J. C. Schäffer, Abbild. Beschr. d. elek. . . . ," Regensberg, 1778; Georg Pickel, "Experimenta physico-medica . . . ," Viceburgi, 1778–1788; J. A. Klindworth, "Kurze Beschr. . . . ," Gotha, 1781–1785; (Lichtenberg's "Magazin," I., 35–45), while for Klindworth, M. Obert and M. Minkeler, see the "Goth. Mag.," I., ii., 35, V., iii., 96, 110; E. G. Robertson, "Sur l'électrophore résineux et papiracé," Paris, 1790; (*Journal de Physique*, vol. XXXVII.); M. Robert on the electrophorus (Rozier, XXXVII., 183); S. Woods, "Essay on the phenomena . . . ," London, 1805; (*Phil. Mag.*, vol. XXI., p. 289); M. Eynard's "Mém. sur l'electrophore," Lyon, 1804; John Phillips, "On a modification of the electrophorus," London, 1833 (*Phil. Mag.*, Sec. III., vol. II.,); G. Zamboni, "Sulla theoria . . . ," Verona, 1844 (Mem. Soc. Ital." vol. XXIII.); F. A. Petrina, "Neue theorie d. elect. . . . ," Prag., 1846; Dr. Thomas Young's "Course of Lectures," vol. II., pp. 432–433.

See, in addition, N. K. Molitor's "John Ingen-housz. Anfangsgrunde . . . ," 1781; Geo. Adams, "Lectures on Mat. and Exp. Philosophy," London, 1799, vol. I., pages 512–515; John Senebier, "Expériences, etc.," 1st and 2d Memoirs, Genève and Paris, 1788; Becquerel in the *Comptes Rendus* for November, 1850, also Tome XXXI., page 633; Mr. Buff (*Phil. Mag.* N. S. vol. VII., page 122); Priestley's "History . . . ," 1775, page 487; Walsh at A.D., 1773; Cavallo's "Exper. Philosophy," 1803, vol. III., page 357; Pouillet (Poggendorff's *Annalen*, Vol. XI., page 430); Reiss, in Poggendorff's *Annalen*, vol. LXXIX., page 288; G. F. Gardini, "De inflexu . . ," § 7, page 10; *Philosophical Transactions* for 1775, 1778, page 1,022, 1779, page 537; *Journal de Physique*, vol. XVI. for 1780; "Erxleben's phys. bibliothek," § 530.

A. D. 1780–1781.——Bertholon de Saint Lazare (Pierre), French physician and professor of natural philosophy, and a great friend of Dr. Franklin, publishes at Paris his "Electricité du Corps Humain, . . .," in which he relates more particularly his general observations upon atmospheric electricity as effecting the human body while in a healthy and while in a diseased condition. He, likewise, treats of the effects of electricity upon animals, and details very interesting experiments upon the *torpedo*, which latter, he remarks, establishes the closest possible resemblance to the Leyden phial.

He is also the author of "Electricité des Métaux" and "Electricité des Végétaux" (1783), as well as of "Electricité des Météores" (1787). J. C. Poggendorff says ("Biog.-Lit. Handw., . . ," vol. II., page 102) that J. Ferd. Meidinger (1726–1777) had previously written concerning the action of electric fire upon metals and minerals. Johann Jacob Hemmer published, at Mannheim in 1780, "Sur l'Electricité des Métaux" ("Ob. sur la Physique," July, 1780, page 50), and A. A. De La Rive wrote in 1835 "De l'Elect. Développée . . ," ("Bibl. Univ.," vol. LIX.).

See Young's "Course of Lectures," vol. II., page 431; Ingen-housz at A. D. 1779; *Journal de Physique*, vol. XXXV.; "Biographie Universelle," vol. IV., page 149; "Biographie Générale," vol. V., page 722; Larousse, "Dict. Univ., vol. II., page 618; "La Grande Encyclopédie," vol. VI., page 450. See also Bertholon's "Nouvelles Preuves, . . ." pages 18–19; Arago, "Notices Scientifiques," vol. I., pages 338–340, 386; "Mercure de France," 1782, No. 52, page 188; Vassalli-Eandi, "Esame della Elett. delle Meteore del Bertholon," Torino, 1787; account of the experiments to ascertain the effects of electricity on vegetation, made in France during the summer of 1878 by M. M. Grandeau, Celi and Leclerc; and a curious publication, "Les Animaux et les Métaux deviennent ils Électriques par communication," by L. Bezaud (Bezault), alluded to in Poggendorff, vol. I., page 146.

A. D. 1780–1783.——Professor Samuel Williams, at Cambridge, Mass., makes the earliest known observations of the magnetic dip in the United States, and publishes them in the "Memoirs of the American Academy of Arts," vol. I., pp. 62, 68. According to this authority, the dip in 1783 was 69° 41′. The next dip observations are those made during Long's expedition to the Rocky Mountains in 1819.

See "American Journal of Science," vol. XLIII., pp. 93, 94; "Trans. Amer. Phil. Soc." O. S. vol. III., p. 115.

A. D. 1780–1794.——Le Père Amyot (Amiot), learned French Jesuit, who was sent in 1751 as a missionary to Pekin, where he resided till his decease in 1794, writes, on the 26th of July, 1780, and also on the 20th of October, 1782, that, as a result of a great number of observations, he finds no change in the variation of the magnetic needle, *i. e.*, that "the point which indicates the north declines westerly from 2 to 2¼ degrees, rarely more than 4¼ degrees, and never less than 2 degrees."

See *Mémoires concernant l'histoire, etc.*, Saillant et Nyon, vol. X., p. 142; Davis, *The Chinese*, vol. III., p. 13.

A. D. 1781.——The so-called compass plant (*Silphium lancinatum*) is first introduced from America into Europe by Mr. Thouin and blooms for the first time in the Botanic Gardens of Upsala, Sweden.

In the *Scientific American* of Feb. 26, 1881, reference is made to the interesting account of this plant given by Sir J. D. Hooker in Curtis' "Botanical Magazine," as well as to the following extract from Professor Asa Gray's report concerning it: "The first announcement of the tendency of the leaves of the compass plant to direct their edges to the north and south was made by General (then Lieutenant) Alvord, of the U. S. Army, during the year 1842, and again in 1844, in communications to the American Association for the Advancement of Science. . . . The lines in "Evangeline" (familiar to many readers)—

> "Look at this delicate plant that lifts its head from the meadow,
> See how its leaves all point to the north as true as the magnet;
> It is the compass plant that the finger of God has suspended,
> Here on its fragile stalk, to direct the traveler's journey,
> Over the sealike, pathless, limitless waste of the desert—"

were inspired by a personal communication made by General Alvord to the poet Longfellow.

In this connection, the following article, headed "A Wonderful Magnetic Plant," translated from *La Nature* by the London *Court Journal*, will prove interesting: There has been discovered in the forests of India a strange plant (*Philotacea Electrica*) which possesses to a very high degree astonishing magnetic power. The hand which breaks a leaf from it receives immediately a shock equal to that which is produced by the conductor of an induction coil. At a distance of six metres a magnetic needle is affected by it, and it will be quite deranged if brought near. The energy of this singular influence varies with the hours of the day. All powerful about 2 o'clock in the afternoon, it is absolutely annulled during the night. At times of storm its intensity augments to striking proportions. During rain the plant seems to succumb and bends its head during a thunder-shower. It remains there without force or virtue even if one should shelter it with an umbrella. No shock is felt at that time in breaking the leaves, and the needle is unaffected by it. One never by any chance sees a bird or insect alight on the electric plant; an instinct seems to warn them that in so doing they would find their sudden death. It is also important to remark that where it grows none of the magnetic metals are found, neither iron, nor cobalt, nor nickel—an undeniable proof that the electric force belongs exclusively to the plant. Light and heat, phosphorescence, magnetism, electricity, how many mysteries and botanical problems does this wondrous Indian plant conceal within its leaf and flower!

An English Thomson-Houston Tramway.

The work on the Roundhay Electric Tramway, Leeds, is to be run on the Thomson-Houston system, and is being pushed on as rapidly as possible. The engine room is now practically complete, with boilers and engine erected. The car bodies, manufactured by Messrs. John Stephenson & Son, of New York, have been received, and excite universal admiration. The poles for the wiring of the route are all set, and the objections heard have been trivial, the in-

habitants rapidly coming to the conclusion that the overhead system is in some places convenient, and much better than nothing. The trucks, motors and generators are daily expected, and probably will have reached England before these lines are in print. Fancy Leeds exchanging woolen stuffs for traction material from America!

Considerations Governing the Choice of a Dynamo.*

BY PROF. E. P. ROBERTS.

To select a dynamo for a given purpose is quite a different affair from designing one. In the latter case the type of machine is first determined and the proportions of the electrical details decided by deduction from theory and experiment. The proportioning of the mechanical parts must be kept in view while designing the electrical features, and both mechanical and electrical elements varied until they unite to best subserve the attainment of the object desired, which is the construction of a dynamo to do the work required with the minimum of first cost and with reliability and economy of operation. A dynamo designer should have, in addition to a knowledge of the laws governing electrical and magnetic circuits, a knowledge of machine design and construction. The knowledge so possessed must be applied to the study of the results following the modification of any feature in the general type and special form chosen. The study of the various losses taking place in a dynamo necessitates an analysis of the same, in order to obtain the value of each loss when the details of the general design are modified. Such losses are friction, ohmic resistance, self-induction, magnetic resistance, magnetic leakage, Foucault currents, hysteresis, etc. After obtaining the above information the dynamo designer will apply his personality—which is partly genius, but mostly the result of varied experience carefully digested—and the result will be a piece of apparatus which will accomplish the object desired with as much certainty as will a special machine tool designed oy an expert in that line.

The purchaser of a dynamo approaches the subject from a very different direction. He desires a dynamo which is, above all, reliable; secondly, efficient as regards the ratio of the power generated to that consumed; and, thirdly, efficient in all the many ways which go to make any machine efficient in every-day use; fourthly (or firstly, secondly or thirdly, according to circumstances, but more generally according to the wisdom of the purchaser), cheap. In order to criticise a dynamo it is advisable to analyze it and study each element. In order to do this systematically the following chart is prepared and then a few remarks made under each heading. The chart refers only to points to be studied by a purchaser. If a dynamo has 90 per cent. commercial efficiency under a certain load, he does not care what disposition is made of the 10 per cent. lost, provided it is not detrimental to the lasting qualities of the dynamo. It is all the same to him if 2 per cent. be lost in Foucault currents and 3 per cent. in ohmic resistance and 5 per cent. in friction, as it would be if the figures were interchanged, provided lubrication and insulation do not suffer.

DYNAMO.	MECHANICAL DESIGN.	*Strength, Rigidity, Accessibility, Lubrication, Revolutions per minute.*
	CONSTRUCTION.	*Material, Workmanship, Balance, Manufactured to Gauge, Insulation.*
	ELECTRICAL DESIGN.	*Commercial Efficiency, Operative Efficiency, Adaptability to Work Desired, Heating, Sparking.*

These points will be considered in the following order:

(1) Mechanical design.

(2) Electrical design.

(3) Construction.

These divisions can be advantageously subdivided, but the line of demarkation is not distinct and remarks under one head will sometimes be repeated in part, or referred to, under other divisions.

(1) Considering the dynamo as a mechanism, there present themselves as to its design: (A) the frame; (B) the bearings; (C) the revolving portion.

(A) The frame should be rigid, should give ease of access to the commutator and brushes for adjustment and cleaning, and should allow repairs to be made with ease and celerity to such parts of the mechanism as are subjected to the greatest stresses, electrical or mechanical, or to constant wear. The frame should make the centre line of the revolving portion as low as practicable, and have a good spread of base.

(B) The bearings should be of ample size, easily replaced and have positive lubrication. Also, arrangements for catching the oil after use should be provided; no oil should creep along the shaft, or be thrown off. Oil, in any other place than the bearings, is not only unsightly and liable to cause fires, but also collects dirt and copper dust from the commutator, causing electrical troubles. Upon the score of economy all oil should be caught and strained and then either mixed with fresh oil and used in the dynamo or used for shaft or other slow speed bearings.

(C) The revolving portion should be firmly fastened to a rigid shaft, and should not depend merely upon set screws or other form of frictional fastening. The shaft should never bend; since if it does, even to a slight degree, increased friction at the bearings will result. Possibly, also, the revolving portion may hit the stationary parts, or the shaft may break after running a short time. The fewer the revolutions per minute the larger the pulley upon the dynamo, and this is important, particularly when the dynamo is driven from shafting, as large pulleys—especially large friction pulleys—are expensive and necessitate considerable space within which to rotate.

(2) *Electrical Design.*

The main point to be considered, under the head of Electrical Design, by the purchaser of a dynamo, is its "commercial efficiency," which is the ratio of the power given out to that absorbed. The power given out is expressed in watts, and that absorbed in foot pounds or horse power. Another kind of commercial efficiency must, however, be considered.

First, the commercial efficiency in its limited sense as above used. Next the output per dollar expended, (a) in buying the dynamo, (b) in furnishing power, (c) in operating expenses of all kinds, and (d) in reliability. Combining these is obtained what is herein termed the "operative efficiency."

It is very evident that an unreliable dynamo is not practically efficient, however well it can be made to perform during testing.

It is of course desirable that the dynamo should have a large output per horse power absorbed, that is, "commercial efficiency," not only when at full load, but under any fraction of the same. It is also desirable that it should have a large output:

Per dollar of first cost.
Per dollar of repairs.
Per dollar of attendance while running.
Per dollar of attendance to clean.
Per pound of total weight.
Per square foot of floor space.
Per cubic foot space (in some locations, as on board ship).

The output per horse power expended at the dynamo pulley to drive the same is a matter easily obtained, to a fair degree of accuracy, without expensive apparatus.

The horse power absorbed can be measured by a number of devices. Numerous forms of transmission dynamometers are in use. An excellent one is the Van Winkle dynamometer. The pulley which transmits power to the dynamo is loose on the shaft and is rotated through the medium of spiral springs, one end of which is fastened to the pulley and the other end to a disc keyed to the shaft. Mechanism is arranged which indicates by a pointer the tension on the spring at any moment. The revolutions per minute being known, the horse power can be computed. A scale is attached, and the horse power transmitted can be directly read. Some prefer to have the figure indicated not to the actual amount, but one the value of which can be found by reference to a private note book. The apparatus is split throughout, so that it can be readily placed upon any shaft, and bushings can be inserted to fit the shaft.

The Brackett cradle is extensively used, and consists of a platform upon which the dynamo is placed, said platform being suspended by end frames carrying knife edges resting upon hardened surfaces. The dynamo shaft is adjusted until its axis passes through the line of the knife edges.

The dynamo is so balanced by weights carried on horizontal arms or on the bed of the cradle, that the latter swings easily and freely on the knife edges, and by means of weights vertically above or below the knife edges the centre of gravity is adjusted until any desired degree of sensitiveness is obtained, viz.: until any desired change on the counterpoise or the horizontal arm throws the cradle out of balance. The centre of gravity must not be raised above the line of support or the cradle will be in unstable equilibrium, *i. e.*, will be top-heavy and will remain tipped to either side. The belt must be off the pulley while adjusting the weight.

When the dynamo is driven the reaction of the armature upon the field tends to rotate the system, and balance is maintained by adjusting the position of the counterpoise on the horizontal arm or by the extension of a spring scale balance attached to it. The continued product of the weight of the counterpoise (or pull on the spring balance), its horizontal distance from the centre line and the revolutions per minute of the dynamo, equals the foot pounds taken by the dynamo.

The number of revolutions per minute may be determined by any one of several devices. A common method is to use a watch and a speed indicator, the point of which is held against the centre of the shaft and the speed is determined by noting the number of revolutions indicated on the dial during a minute or any convenient fraction thereof. This method is rather troublesome unless two observers are available, one to attend to the indicator and the other to call time. A convenient instrument combines the indicator with a stop watch in such a way that the rotating point operates the registering device only for a certain length of time, so that the revolutions per minute are indicated directly. Another class of instrument is the tachometer, which may either be operated by a belt or may be held against the end of the shaft. In the tachometer centrifugal force causes a pointer to move along a scale graduated to read revolutions per minute. The greatest source of inaccuracy in the use of any of these instruments is the liability to slip. This is minimized in the case of instruments operated by contact against the end of the shaft by having sharp edges on the point or giving it a soft rubber tip. A good method is to use a three-edged punch and punch the "centre" with the same. The marks thus made hold the point of the counter and do not injure the centre. In the use of the tachometer and belt care should be taken that the belt is tight and that the pulley on the shaft is of the exact size required. When an indicator is not obtainable the speed may be determined approximately by counting the revolutions of engine or shaft and multiplying by the ratio between the diameters of pulleys. The speed of the engine may be counted by letting one hand move by some reciprocating part or allowing some part, such as a set screw, on the shaft or crankpin of the engine, to strike the hand at each revolution while a watch is held in the free hand.

One make of engine, the Ide, has ar indicator of horse-power being developed. It really shows the point of cut-off. The number of revolutions and initial pressure of steam being known, the horse power is determined, and the scale calibrated accordingly. If the friction be deducted, the amount being obtained by friction cards, the horse power transmitted to the dynamos is closely approximated.

ENERGY DEVELOPED BY THE DYNAMO.

The energy now to be considered is that delivered by the machine to the external circuit. The location and character of the electrical losses in the dynamo need not be taken into account by the station operator, with the exception of the consideration that energy lost in the dynamo is converted into heat, and in general the less heating the better will be the "operative" and "commercial" efficiency.

In order to determine the output of the dynamo, it is necessary to measure the difference of potential (P. D.) external circuit. This is usually accomplished by a voltmeter and an ammeter of the proper range to take the measurements desired. In whatever way the P. D. and C. are determined, their product gives the energy in watts and this divided by 746 gives electrical horse power. Electrical horse power is the same as the standard mechanical horse power, which is the work done by 33,000 pounds falling one foot per minute, or the equivalent of the same.

In order to determine whether the dynamo will do the character of work desired it is operated at the speed given by the manufacturer (not at some other speed and calculations made therefrom) and the C. and P. D. at the terminals measured, the energy developed being absorbed by any form of R. convenient. A curve showing the C. and generator P. D. at various loads is constructed from data so obtained. If desirable curves are made showing the output at various speeds. These curves are called "*characteristics*," and bear much the same relation to a dynamo that an indicator diagram does to a steam engine.

In some cases it is well to prove the dynamo by "short circuiting" it, and sometimes by suddenly "open circuiting" it. Also to test the effect of slight variations in the position of the brushes.

From a financial standpoint the output per dollar expended is evidently of importance, and under the same head can generally be placed, though to a lesser degree, the output per square foot of floor space occupied; and, where height must be considered, the output per cubic foot of space, and sometimes also per pound of weight. In most station work, however, the weight and height need not be considered as between dynamos of the same output. A large dynamo is cheaper and occupies less floor space per watt developed than its equivalent of smaller ones.

The allowance for repairs is generally figured as a certain percentage of the first cost, and is determined by experience. This is a very uncertain quantity, but where great care is taken to properly clean the dynamo and keep the same in good condition (such as shellacing impaired insulation, etc.), and where open and short circuits do not occur on the line when operating, and the lightning arresters act properly, the repairs upon dynamos are usually very small, possibly not two per cent. per annum of the cost. In other cases it may reach any imaginable figure.

The output per dollar of attendance to clean is, more or less, the reciprocal of the above. The more cleaning the less repairs. Some dynamos, however, take much longer to clean than others and some can never be thoroughly cleaned. The cleaning of dynamos is quite an expense in a large station and an even larger percentage of cost in a small one, as a comparatively expensive man may have to do it at times when otherwise he might be more productively engaged.

The output per dollar of attendance while running varies greatly. With some dynamos and their auxiliary mechanisms so much attendance is necessary as to be a considerable item in a small station, taking all of one man's time in a medium sized station and the time of more than one man if a large number of dynamos are running. This emphasizes the fact, which no one not an operating manager and superintendent of a station fully realizes, that in choosing a system there are many points to be considered besides commercial efficiency, first cost and electrical output of the character desired and as indicated by the characteristic curve.

The mechanical design should be such that the electrical functions of the different parts may not be destroyed by reason of insufficient rigidity, abrasion, etc. It is well to have the armature wires positively driven by the pressure of the parts of the armature frame. When an armature

*Paper in the *Journal of the Association of Engineering Societies.*

revolves rapidly, the wires, including the binding wires upon armatures using such, stretch and are liable to be more or less displaced unless firmly held. If shaft wires are used passing through the shaft to the collector, special care should be given to insure a smooth and ample space for placing the same in position and that dirt be not allowed to settle about the entrance and egress holes. The mechanical design of the commutator includes the matter of proper insulating material between each of the commutator strips and between them and the shaft, the whole being put together in such a way that no piece is liable to work loose.

The electrical design necessitates that there shall not be continuity of the iron of the armature core. The reason for this is that the same force which tends to produce current in the wire would produce current in the iron and heat it if the electrical circuit be complete. Such currents are called Foucault currents. Armature cores are, therefore, made of iron plates, bands or wire; plates being used when the active wire is parallel to the shaft, bands when at right angles and wire being applicable to either case.

Heating.—Excessive heat will gradually carbonize the insulations of wires and render them brittle and destroy their insulating properties. A safe temperature should not be exceeded after a three hours' run at full load.

What temperature is safe depends upon what the insulation will stand. In other words, high temperature is only injurious, from the standpoint of reliability, because the insulation may be deteriorated, and the extent of insulation required is a function of the P. D., which may be increased much above its normal value when the circuit under consideration is suddenly opened, particularly if such consists of many turns about an iron core.

When the windings are of considerable depth the external layers are cooler than the internal. In case of an armature, the external layers will be much cooler when running than those after stopping, as then the conduction of heat will not take place as rapidly, owing to less cool air coming in contact with the wires, and the temperature of the external wires will become more nearly that of the internal layers.

In any case it is advisable not to have the temperature rise so high that the back of the hand cannot be held against the wires.

Sparking.—The action of the commutating and collecting devices is, in many respects, a guide to the electrical action of the dynamo. If the dynamo be of the open coil type and designed for high E. M. F. and small current, a spark of considerable length can be run without burning the commutator. Such a spark may be run for a year or more on a machine properly attended to, and very little wear be perceptible. In closed coil machines, and in all large "quantity" machines, the less spark the better. Many may now be observed in operation with almost no perceptible spark, or even scintillation. If the field and armature are electrically balanced this can be accomplished, but the art of so balancing them is outside the province of a station constructing engineer. Whether the brushes are to remain unmoved and non-sparking for changes of load, or whether automatic or hand movement must necessarily or advisably accompany such changes, depends often upon the place where the dynamo is located, and the character of the work desired. In other words, whether constant attendance is necessarily provided for other work than to shift brushes, and, therefore, will be always at hand; and whether large percentage variations are liable to occur at any moment and unexpectedly. Generally speaking everything should be automatic, but sometimes government is obtained by such a multiplication of devices, and accompanied by so many losses of power, that the advantages are not commensurate with the losses, and particularly with the attention necessarily given to keeping the automatic devices in order. The cost of time taken for this by an expert may even exceed that of comparatively unskilled labor for hand regulation.

The commutator and brushes constitute an important part of the dynamo, since the successful collection of the current depends upon their satisfactory operation. As shown before, the requisite quality of the commutator is that it presents a uniform, smooth and clean surface moving with moderate peripheral speed, against which the brushes may maintain easy but sure contact. Likewise the condition to be met by the brushes and their attendant mechanism is that they maintain sure and continuous contact with the revolving commutator, at the same time being well connected to the stationary conductor. This requires that the brush shall be of some good conducting material or that the holder grasp it as near as practicable to the commutator. The brush or the enclosing holder should have a certain amount of springiness. They should preferably be capable of adjustment while running without opening the circuit. Much ingenuity has been exercised upon the development of satisfactory brushes and holders, and many excellent designs are to be found on different machines on the market.

In a few machines the brushes are made to bear tangentially upon the commutator, but in most cases they bear obliquely. Tangential brushes have only a small surface of contact and are easily kept in order. The principal points to be looked after are to see that the brushes do not get worn through at the line of contact and that they retain their elasticity and certainty of contact.

With the brushes set at an angle the surfaces of contact with the commutator are wider, being usually best when equal to the circumferential width of one commutator bar. The brushes should be filed off square and beveled to the desired angle, then set in the holders or clamps so that the beveled surfaces bear evenly upon the commutator: they should then be fastened tightly so that they cannot work loose or change position, and the springs adjusted to the proper tension for securing good contact with the minimum friction. The brushes should be kept clean, so as to make good electrical contact both with the commutator and the holders. The ends should not be allowed to become dirty, rough or ragged, and may be cleaned occasionally by washing in benzine. As the brushes wear they gradually change their angle and their position on the commutator and leave the non-sparking point. They should, therefore, be trimmed occasionally and reset. Care must be taken that the brushes touch the commutator at diametrically opposite points, and, to facilitate resetting, a pair of opposite bars should be marked with a centre punch or chisel mark.

It is desirable, especially for machines giving large quantity of current, that there be two, or more, brushes on a side, both to reduce the resistance by increasing the amount of surface between brush and commutator, and so that the operation of the machine will not be entirely dependent upon the proper working of any one brush. When there is more than one brush on a side they should all be set in a line so as not to cover a wider angle on the commutator than should be covered by any one brush, unless such separation of brushes is part of the means for regulating the dynamo.

"Carbon brushes" have recently come into quite general use and are popular, since they do not require so much attention and care as those of copper. They also reduce that part of the sparking due to the short circuiting of armature coils, when the brushes touch two adjacent commutator bars, since the carbon brushes have more resistance than those of copper. In many cases the carbon brushes simply replace the copper ones and are used in the same holders, but more frequently special holders are used.

When the commutator is in good order and the brushes well set so that there is little sparking, the commutator will acquire a glazed surface and will run for months with no other attention than being occasionally oiled. To reduce the abrasion between commutator and brushes a certain amount of lubrication is desirable, but this should not be excessive, since lubricators, as a rule, are insulators, and their presence between the brushes and commutator, except in very small quantity, introduces injurious resistance. A small amount of resistance from this source is less objectionable with high tension machines than with low tension. Too much lubrication will prevent the brushes from making good contact, and the sparking that follows will char the oil and insulation, and cause more or less short circuiting of the commutator. Some makers provide automatic commutator oilers, but for most cases occasional wiping of the commutator with a piece of cloth or felt impregnated with oil or vaseline is sufficient. For low tension machines a convenient and satisfactory plan is to put a drop or two of oil on a clean finger, shake off the excess, and rub the finger over the commutator. Some of the carbon brushes are partially composed of graphite, which furnishes the desirable amount of lubrication. Another plan is to boil the carbons in vaseline, which will serve the same purpose without lessening the conductivity of the brush.

When the surface of the commutator becomes dark and dirty it should be scoured off with fine sand-paper. The commutator should not be allowed to get dry, since it then scours and there is more or less cutting of both brush and commutator, accompanied with undesirable throwing of copper and carbon dust.

Construction.—This can be suitably examined under the heads of Material, Workmanship, Balance of Rotating Parts, Methods of Manufacture and Insulation.

Material should be what it is represented to be. There is little danger of an efficient dynamo being lacking under this head, unless, possibly, a flaw be found in the shaft or pulley.

Workmanship is to be judged from the standpoint of a machinist who has a knowledge of the electrical functions of the different parts. An electrical machinist used to dynamo work is needed to find flaws in workmanship.

Balance.—It is very important, not only for quiet but for continued running, that the revolving portion should be in good running balance. If the armature is of the disc pattern on a long shaft, a static balance will give a "running" or dynamic balance. If, however, the armature be of the drum pattern, a system such as is used by the Alliance Company or a machine of the character designed by the writer should be used.

Method of Manufacture. (*Gauge or Interchangeable System.*—It seems hardly creditable that in these times and in this country any machine made in quantities should not be made to gauge; but sometimes it is a fact that a part of a machine "made to gauge" breaks, and the new part does not, unaccountably perhaps, fit.

Insulation.—The insulation of any machine is usually designed with reference to the E. M. F., and for safe running in a dry locality. If dampness or injurious vapors or excessive heat be present, special insulation should be provided. When a dynamo has become wet it can be dried out by means of a current. It is best to obtain such current from an external source, as then the P. D. between continuous portions is only that due to the R. and not that generated in such portions when acting as a dynamo. If time is not of importance it can be dried with more safety by placing it upon a boiler and having the core of the magnet rest upon the shell or dome. This method will, generally, take two weeks to dry out a deep winding.

If an electrical engineer be employed to examine a dynamo, he may not actually write out his opinion under each of the above headings. He will determine the characteristics and horse power consumed, and many of the other points will be merely considered together under the head of excellent, fair or poor in electrical or mechanical details, or in both.

An electrical engineer who has not had enough experience to grasp as it were intuitively the detail feature and decide thereon without actual analysis, is very liable to a more or less serious omission and regret it afterward, unless he proceeds in a systematic manner. In any case system is advisable, and clients will have a better opinion of a paper which takes up its subject and deals with it fully and comprehensively than if generalities only be presented and those of the character of the Delphic oracle.

Dr. Oliver Lodge's Presidential Address to Section A. of the British Association.*

During the past year three or four events call for special mention in an annual deliverance of this kind by a physicist. One is the Faraday centenary, which was kept in a happy and simple manner by a cosmopolitan gathering in the place so long associated with his work, and by discourses calling attention to the modern development of discoveries made by him. Another is the decease of the veteran Wilhelm Weber, one of the originators of that absolute system of measurement which, though still ungrasped in its simplicity and completeness by the majority of men engaged in practice, nor even, I fear, wholly understood by some of those engaged in university teaching, has yet done so much, and is destined to do still more, for the unification of physical science, and for a thorough comprehension of its range and its limitations. A third event of importance during the year is the discovery in America of a binary system of stars, revolving round each other with grotesque haste, and with a proximity to each other such as to render their ordinary optical separation quite impossible. The change in the refrangibility of light by reason of the motion of its source, though commonplace enough now, was at first regarded as too small to be observed, and one or two attempts directed to detecting the effect of this principle on the spectra of the stars, or sometimes on sunlight reflected by a 45-degree mirror into the line of the earth's motion (which is not a possible method), wholly failed. I take pleasure in remembering that this effect was clearly observed for the first time by the gentleman we this year honor as our president; and that it is by this very means that the latest sensational discovery in astronomy of the rapidly revolving twin star, β-Aurigæ, by Prof. Pickering and the staff connected with the Draper Memorial, was made. The fourth event to which it behooves me to refer is the practical discovery of a physical method for color photography. The first suggestion of the method, so far as I know, was made by Lord Rayleigh in the course of a mathematical paper on the reflection of light, and with reference to some results of Becquerel obtained on a totally different plan. He said in a note that if by normal reflection waves of light were converted into stationary waves, they could shake out silver in strata half a wave-length apart, and that such strata would give selective reflection and show iridescence. Independently of all this, Herr Otto Wiener, imitating Hertz's experiments with ordinary light in 1889, reflected a beam directly back on itself, and, by interposing a very thin collodion film at extraordinarily oblique incidence, succeeded in the difficult experiment of so magnifying, by the cosine of inclination, the half-wave length as to get the silver deposited in strata of visible width, and thus to photograph the interference nodes themselves at the places where they were cut by the plane of the film. Then M. Lippmann, using a thicker film, not put obliquely but normal to the light, obtained the strata within the thickness of the film itself—hundreds of layers; and so, employing incident light of definite wave-length, was able to produce a stratified deposit, which reflected back at appropriate incidences the same wave-length as produced it; thus reproducing, of course, the definite color.

I now leave the retrospect of what has been done, although many other topics might usefully detain us, and I proceed to glance forward at the progress ahead and at the means we have for effectively grappling with our due share of it. There is a subject which has long been in my mind, and which I determined to bring forward whenever I had a cathedral opportunity of doing so; and now, if ever, is a suitable occasion. It is to call attention to the fact that the further progress of physical science in the somewhat haphazard and amateur fashion in which it has been hitherto pursued in this country is becoming increasingly difficult, and that the quantitative portion especially should be undertaken in a permanent and publicly supported physical laboratory on a large scale. If such an establishment were to weaken the sinews of private enterprise and individual research it should be strenuously opposed; but, in my opinion, it would have the opposite effect, by relieving the private worker of much which he can only with great

* Abstract. From *The Electrician*, London.

difficulty, sacrifice and expense undertake. To illustrate more precisely what I mean, it is sufficient to recall the case of astronomy. The amateur astronomer has much work lying ready to his hand, and he grapples with it manfully. To him is left the striking out of new lines and the guerrilla warfare of science. Skirmishing and brilliant cavalry evolutions are his natural field; he should not be called upon to take part in the general infantry advance. It is wasting his energies, and he could not do it in the long run well. What, for instance, would have been the state of astronometry—the nautical almanac department of astronomy—without the consecutive and systematic work of the National Observatory at Greenwich? It may be that some enthusiastic amateurs would have devoted their lives to this routine kind of work; and here at one time, and there at another, a series of accurate observations would have been kept for several years. Pursued in that way, however, not only would the effort be spasmodic and temporary, but the energy and enthusiasm of those amateurs would have been diverted from the pioneering more suited to them, and have been cramped in the groove of routine, eminently adapted to a permanent official staff but not wholesome for an individual. Long continued consecutive observations may be made by a leader of science, as functions may be tabulated by an eminent mathematician; but if the work can be done almost equally well (some would say better) by a professional observer or computator, how great an economy results.

Now all this applies equally to physics. The ohm has been determined with 4-figure, perhaps with 5-figure accuracy; but think of the list of eminent men to whose severe personal labor we owe this result, and ask if the spoil is worth the cost. Perhaps, in this case, it is, as a specimen of well conducted determination. We must have a few specimens, and our leaders must show us the way to do things. But let us not continue to use them for such purposes much longer. The quest of the fifth or sixth decimal is a very legitimate, and may become a very absorbing quest, but there are plenty of the rank and file who can undertake it if properly generaled and led; not as isolated individuals, but as workers in a national laboratory under a competent head and a governing committee. By this means work far greater in quantity, and, in the long run, more exact in quality, can be turned out, by patient and conscientious labor without much genius, by the gradual improvement of instrumental means, by the skill acquired by practice, and by the steady drudgery of routine. Paris has long had one form of such an institution in the Conservatoire des Arts et Métiers, and has been able to impose the metric system on the civilized world in consequence. It can also point to the classical determinations of Regnault as the fruits of just such a system. Berlin is now starting a similar or a more ambitious scheme for a permanent national physical institute. Is it not time that England, which in physical science, I venture to think, may in some sort claim a leading place, should be thinking of starting the same movement?

The Meteorological and Magnetic Observatory at Kew (in the inauguration of which this association took so large a part) is a step, and much useful quantitative work is done there. The new Electric Standardizing Laboratory of the Board of Trade is another, and, in some respects perhaps, a still closer approximation to the kind of thing I advocate. But what I want to see is a much larger establishment, erected on the most suitable site, limited by no specialty of aim nor by the demands of the commercial world, furnished with all appropriate appliances, to be amended and added to as time goes on and experience grows, and invested with all the dignity and permanence of a national institution; a Physical Observatory, in fact, precisely comparable to the Greenwich Observatory, and aiming at the very highest quantitative work in all departments of physical science. That the arts would be benefited may be assumed without proof. It is largely the necessity of engineers that has inspired the amount of accuracy in electrical matters already attained. The work and appliances of the mechanical engineer eclipse the present achievements of the physicist in point of accuracy, and it is by the aid of the mechanician and optician that precision even in astronomy has reached so high a stage. There is no reason why physical determinations should be conducted in an amateur fashion, with comparatively imperfect instruments, as at present they mostly are. Discoveries lie along the path of extreme accuracy and they will turn up in the most unexpected way. The aberration of light would not have been discovered had not Bradley been able to measure to less than 1 part in 10,000; and what a brilliant and momentous discovery it was! He was aiming at the detection of stellar parallax, but the finite velocity of light was a bigger discovery of light than any parallax. This is the type of result which sometimes lurks in the fifth decimal, and which confers upon it an importance beside which the demands of men who wish to serve the taste and the pocket of the British public sink into insignificance.

In a national observatory accuracy should be the one great end: the utmost accuracy in every determination that is decided on and made. Only one thing should be more thought of than the fifth significant figure, and that is the sixth. The consequences flowing from the results may safely be left; such as are not obvious at once will distill themselves out in time. And the great army of outside physicists, assured of the good work being done at headquarters will (to speak again in astronomical parable) cease from peddling with taking transits or altitudes, and will be free to discover comets, to invent the spectroscope, to watch solar phenomena, to chemically analyze the stars, to devise celestial photography, and to elaborate still more celestial theories, all of which novelties in their maturity may be handed over to the National Observatory, to be henceforth incorporated with, and made part of, its routine life, leaving the advance guard and skirmishers free to explore fresh territory, secure in the knowledge that what they have acquired will be properly surveyed, mapped and utilized, without further attention from them. As to the practical applications, they may in any case be left to take care of themselves. The instinct of humanity in this direction, and the so-called solid gains associated with practical achievements, will always secure a sufficient number of acute and energetic workers to turn the new territory into arable land and pasture adapted to the demands of the average man. The labor of the agriculturist in rendering soil fertile is, of course, beyond praise; but it is not the work of the pioneer. As Mr. Huxley eloquently put it, when contrasting the application of science with the advance of science itself, speaking of the things of commercial value which the physical philosopher sometimes discovers: "Great is the rejoicing of those who are benefited thereby, and, for the moment, science is the Diana of all the craftsmen. But even while the cries of jubilation resound, and this flotsam and jetsam of the tide of investigation is being turned into the wages of workmen and the wealth of capitalists, the crest of the wave of scientific investigation is far away on its course over the illimitable ocean of the unknown."

I have spoken of the work of the National Laboratory as devoted to accuracy. It is hardly necessary to say that it will be also the natural custodian of our standards, in a state fit for use and for comparison with copies sent to be certified. Else, perhaps, some day our standard ohm may be buried in a brick wall at Westminster, and no one living may be able to recall precisely where it is.

But, in addition to these main functions, there is another, equally important with them, to which I must briefly refer. There are many experiments which cannot possibly be conducted by an individual, because 40 and 50 years is not long enough for them. Secular experiments on the properties of materials—the elasticity of metals, for instance; the effect of time on molecular arrangement; the influence of long exposure to light, or to heat, or to mechanical vibration, or to other physical agents. Does the permeability of soft iron decay with age, by reason of its Ampèrian currents? Do gases cool themselves when adiabatically preserved, by reason of imperfect elasticity or too many degrees of freedom of their molecules? Unlikely, but not impossible. Do thermo-electric properties alter with time? And a multitude of other experiments which appear specially applicable to substances in the solid stage—a state which is more complicated, and has been less investigated, than either the liquid or the gaseous; a state in which time and past history play an important part.

Whichever of these long researches requires to be entered on, a national laboratory, with permanent traditions and a continuous life, is undoubtedly the only appropriate place. At such a place as Glasgow the exceptional magnitude of a present occupant may, indeed, inspire sufficient piety in a successor to secure the continuance of what has been there begun; but in most college laboratories, under conditions of migration, interregnum, and a new régime continuity of investigation is hopeless.

I have at any rate said enough to indicate the kind of work for which the establishment of a well furnished laboratory with fully equipped staff is desirable, and I do not think that we, as a nation, shall be taking our proper share of the highest scientific work of the world until such an institution is started on its career. There is only one evil which, so far as I can see, is to be feared from it: if ever it were allowed to impose on outside workers as a central authority, from which infallible dicta were issued, it would be an evil so great that no amount of good work carried on by it could be pleaded as sufficient mitigation. If ever by evil chance such an attitude were attempted, it must rest with the workers of the future to see that they permit no such shackles; for if they are not competent to be independent, and to contemn the voice of authority speaking as mere authority, if their only safeguard lies in the absence of necessity for struggle and effort, they cannot long hope to escape from the futility which surely awaits them in other directions.

I am thus led to take a wider range, and, leaving temporary and special considerations, to speak of a topic which is as yet beyond the pale of scientific orthodoxy, and which I might, more wisely, leave lying by the roadside.

Our ancestors fought hard and suffered much for the privilege of free and open inquiry, for the right of conducting investigation untrammeled by prejudice and foregone conclusions, and they were ready to examine into any phenomenon which presented itself. This attitude of mind is, perhaps, necessarily less prominent now, but it would be a great pity if a too absorbed attention to what has already been acquired, and to the fringe of territory lying immediately adjacent thereto, were to end in our losing the power of raising our eyes and receiving evidence of a totally fresh kind, of perceiving the existence of regions into which the same processes of inquiry as had proved so fruitful might be extended, with results at present incalculable and perhaps wholly unexpected. I myself think that the ordinary processes of observation and experiment are establishing the existence of such a region; that, in fact, they have already established the truth of some phenomena not at present contemplated by science, and to which the orthodox man shuts his ears.

Everybody is by no means bound to investigate everything: though, indeed, it is customary in most fields of knowledge for those who have kept aloof from a particular inquiry to defer in moderation to those who have conducted it, without feeling themselves called upon to express an opinion. Some there are, no doubt, who consider that they have given sufficient time and attention to the subject with only negative results. Their evidence is, of course, important; but, plainly, negative evidence should be of immense bulk and weight before it can outweigh even a moderate amount of positive evidence. However, it is not of the action of individuals that I wish to speak, it is of the attitude to be adopted by scientific bodies in their corporate capacity; and for a corporate body of men of science, inheritors of the hard won tradition of free and fearless inquiry into the facts of Nature untrammeled by prejudice, for any such body to decline to receive evidence laboriously attained and discreetly and inoffensively presented by observers of accepted competency in other branches, would be, if ever actually done and persisted in, a terrible throwing away of their prerogative and an imitation of the errors of a school of thought against which the struggle was at one time severe.

Now let me be more definite, and try to state what this field is, the exploration of which is regarded as so dangerous. I might call it the border land of physics and psychology. I might call it the connection between life and energy; or the connection between mind and matter. It is an intermediate region, bounded on the north by psychology, on the south by physics, on the east by physiology, and on the west by pathology and medicine. An occasional psychologist has groped down into it and become a metaphysician. An occasional physicist has wandered up into it and lost his base, to the horror of his quondam brethren. Biologists mostly look at it askance, or deny its existence. A few medical practitioners, after long maintenance of a similar attitude, have begun to annex a portion of its western frontier. The whole region seems to be inhabited mainly by savages, many of them, so far as we can judge from a distance, given to gross superstition. It may, for all I know, have been hastily traversed and rudely surveyed by a few clear-eyed travelers; but their legends concerning it are not very credible, certainly are not believed. Why not leave it to the metaphysician? I say it has been left to them long enough. They have explored it with insufficient equipment. The physical knowledge of the great philosophers has been necessarily scanty. Men of genius they were, and their writings may, when interpreted, mean much. But to us, as physicists, they are unsatisfactory; their methods are not our methods. They may be said to have floated a balloon over the region with a looking-glass attached, in which they have caught queer and fragmentary glimpses. They may have seen more than we give them credit for, but they appear to have guessed far more than they saw. Our method is different. We prefer to creep slowly from our base of physical knowledge, to engineer carefully as we go, establishing forts, making roads, and thoroughly exploring the country; making a progress very slow, but very lasting. The psychologists from their side may meet us. I hope they will; but one or other of us ought to begin.

A vulnerable spot on our side seems to be the connection between life and energy. The conservation of energy has been so long established as to have become a commonplace. The relation of life to energy is not understood. Life is not energy, and the death of an animal affects the amount of energy no whit; yet a live animal exerts control over energy which a dead one cannot. Life is a guiding or directing principle, disturbing to the physical world, but not yet given a place in the scheme of physics. The transfer of energy is accounted for by the performance of work; the guidance of energy needs no work, but demands force only. What is force? and how can living beings exert it in the way they do? By what means is force exerted, and what, definitely, is force? I can hardly put the question here and now so as to be intelligible, except to those who have approached and thought over the same difficulties; but I venture to say that there is here something not provided for in the orthodox scheme of physics; that modern physics is not complete, and that a line of possible advance lies in this direction. But the whole region is unexplored territory, and it is conceivable that matter may react on mind in a way we can at present only dimly imagine. In fact, the barrier between the two may gradually melt away, as so many other barriers have done, and we may end in a wider perception of the unity of nature, such as philosophers have already dreamt of. I care not what the end may be. I do care that the inquiry shall be conducted by us, and that we shall be free from the disgrace of jogging along accustomed roads, leaving to outsiders the work, the ridicule and the gratification of unfolding a new region to unwilling eyes.

It may be held that such investigations are not physical and do not concern us. We cannot tell without trying. In that I trust my instinct. I believe there is something in this region which does concern us as physicists. It may concern other sciences too. It must, one would suppose, some day concern biology; but with that I have nothing to

do. Biologists have their region, we have ours, and there is no need for us to hang back from an investigation because they do. Our own science, of Physics or Natural Philosophy in its widest sense, is the King of the Sciences, and it is for us to lead, not to follow. Now I say that the doctrine of ultimate intelligibility should be pressed into other departments also. At present we hang back from whole regions of inquiry and say they are not for us. A few we are beginning to grapple with. The nature of disease is yielding to scrutiny with fruitful result; the mental aberrations and abnormalities of hypnotism, duplex personality and allied phenomena are now at last being taken under the wing of science, after long ridicule and contempt. The phenomenon of crime, the scientific meaning and justification of altruism, and other matters relating to life and conduct, are beginning, or perhaps are barely yet beginning, to show a vulnerable front over which the forces of science may pour. What we know is as nothing to that which remains to be known. This is sometimes said as a truism; sometimes it is half doubted. To me it seems the most literal truth, and that if we narrow our view to already half-conquered territory only, we shall be false to the men who won our freedom, and treasonable to the highest claims of science.

I must now return to the work of this section, from which I have apparently wandered rather far afield, further than is customary, perhaps further than is desirable. But I hold that occasionally a wide outlook is wholesome, and that without such occasional survey the rigid attention to detail and minute scrutiny of every little fact, which are so entirely admirable and are so rightly here fostered, are apt to become unhealthy, dull and monotonous. Our lifework is connected with the rigid framework of facts, the skeleton or outline map of the universe; and, though it is well for us occasionally to remember that the texture and color and beauty which we habitually ignore are not therefore in the slightest degree non-existent, yet it is safest speedily to return to our base and continue the slow and laborious march with which we are familiar and which experience has justified. It is because I imagine that such systematic advance is now beginning to be possible in a fresh and unexpected direction that I have attempted to direct your attention to a subject which, if my prognostications are correct, may turn out to be one of special and peculiar interest to humanity.

The New Postmaster-General of Great Britain.

The important position of Postmaster-General of Great Britain, left vacant by the death of the Hon. Cecil Raikes, has been accepted by Sir James Fergusson. He was born in Edinburgh in 1832, educated at Rugby and Oxford, served in the Crimean campaign, has been Under Secretary for India and for the Home Department; he was appointed Governor of South Australia in 1868, and in 1873 became Governor of New Zealand; from 1880 to 1885 he was Governor of Bombay, and since then has been Under Secretary for Foreign Affairs.

Electric Lighting in Coal Mines.

The H. C. Frick Coal and Coke Company, of Pittsburgh, Pa., the largest coal operators in the world, have just completed arrangements for the illumination of their many mines by electricity, in fact the plans have already so far advanced that the lighting of two mining plants has been successfully accomplished. The contract for the work has been awarded to the Westinghouse Electric and Manufacturing Company, under whose supervision the work of installing the lighting plants was conducted. The first two mines to be lighted by electric lights were the Leisenring No. 1 and Leisenring No. 2. The operation of the lights was commenced a few days ago. Everything turned out to the greatest satisfaction of the Westinghouse and Frick companies.

The mines of the company are mostly situated in the Connellsville region, in Westmoreland and Cambria counties, Pa., and a number of them are shaft mines, varying in depth from 100 to nearly 1,000 feet. Owing to the accumulation of firedamp and gas in many of these mines the lighting has always been a very grave problem, because almost every known method of illumination included the danger of causing the mine to catch fire. This led at last to the attempt of utilizing the electric current for lighting purposes. The wonderful success which was immediately established upon the first experiments is causing a rapid superseding of all other methods of lighting by the electric illumination.

The Westinghouse company has been one of the first electrical corporations to realize the vastness of this field, and commenced to pay attention to the subject of "electricity in mines" several years ago. The result has been that they have gained an experience in that branch of the business, the application of which has proved eminently successful. Many of the mines in Western Pennsylvania have installed Westinghouse apparatus, and not long ago the company completed the installation of a mine in the iron ore district of Lake Superior.

The Frick Company has adopted the method of lighting each mine independently, and at every mine is installed Westinghouse direct current apparatus of sufficient capacity to light up the mine below and above the ground. The lamps are distributed underground throughout the main walks leading to the shaft. In addition, the tipple above ground, the engine house and other surface buildings are also lighted. The lamps vary in candle power from 16 to 50 c. p.

Electric light plants are now being put up at Leisenring No. 3, Trotter and Standard mine—the latter, by the way, is said to be the largest coal mine in the world—but it will probably take a whole year before the plants for all the mines are installed.

On the Magnetic Field in the Neighborhood of the South London Electrical Railway.*

BY PROFS. AYRTON AND RÜCKER, FF. R. S.

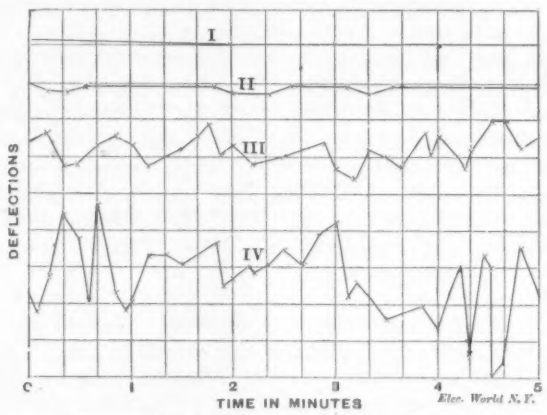
In the spring of the present year we were both interested in the question as to how far the work of a physical laboratory would be affected by the neighborhood of an electrical railway.

The South London Electrical Railway runs from Stockwell to the city. It is constructed under the public road at a depth of 60 or 70 feet below the surface. The up and down lines are carried in separate tunnels and enclosed in large iron tubes. The current is conveyed to the trains by an insulated rail, and the circuit is completed through the rails on which the trains run, which probably are or were themselves in communication with the iron tubes and thus with the earth.†

Our observations were made at a house (No. 122) in Kennington Park road, under which the railway runs, in two rooms, at points distant about 60 feet and 200 feet from the middle of the road respectively.

The instruments used were (1) a rough magnetometer, consisting of needles attached to a mirror suspended by a silk thread about three inches long; and (2) an ordinary Elliott square pattern mirror galvanometer, which was used as a magnetometer.

All observations were made when the period of vibration of the instrument used was about 10 seconds. To compare the magnetic disturbances with those due to mere mechanical vibrations, the magnets were removed from another similar galvanometer and replaced by copper rods of about the same mass. The mirror was then suspended by a bifilar which gave a period of about 10 seconds. This was only intended to detect the effects of shaking on the galvanometer, and it may be sufficient to say that it proved conclusively that, at Kennington Park road, the tremors due to



Curves Showing the Effect of an Electric Railway on the Neighboring Magnetic Field.

the traffic might be almost neglected as sources of disturbance when compared with the magnetic effects of the railway.

The latter were continuous and very great. On one occasion, when the line was blocked, the instruments were at rest. The oscillations began again at or within a few seconds of the time when a train which had been detained in the neighboring station left it. This coincidence was most satisfactorily established, as some of our party were noting the times of the arrival and departure of the trains, while others were also noting the instants at which the largest disturbances of the instruments occurred.

The passage of a train caused a very sudden disturbance of the needle, especially in the room nearest the line; but the amplitude of these vibrations, though greater, was often not much greater than that of those which were continually occurring at other times.

At 60 feet from the middle of the road the larger deflections produced on a scale one metre distant from the instruments were about ± 20 millimetres. At the more distant position, about 200 feet from the road, they were about two and a half times less.

As the instruments were about 10 feet above the roadway, and probably about 70 feet above the line, the distances from the line at the two stations were roughly $\sqrt{60^2 + 70^2}$ and $\sqrt{200^2 + 70^2}$, or 92 and 212 feet respectively. The ratio of these numbers is 2.3, and as the ratio of the disturbances at the two stations was about 2.5 it is evident that they diminish very slowly as the distance increases. The law of the inverse distance was apparently approximately fulfilled.

To show the effects of the railway we publish the comparative diagrams in curves I. to IV.

Readings of an Elliott galvanometer arranged as above described were taken every 10 seconds in (1) a laboratory of the Royal College of Science about 150 feet west of the middle of Exhibition road, (2) another laboratory about 70 feet east of the same road, (3) a room at Kennington Park road about 200 feet from the middle of the road, (4) a room at Kennington Park road 60 feet from the middle of the road.

Curves I. to IV. show the results at each place, the ordinates being the actual deflections observed.

The irregularities in curve II. were no doubt due to a dynamo which was working at some distance. Curves III. and IV. show the effects of the railway and prove conclusively that ordinary students' work would be impossible in its neighborhood. To emphasize the fact that the standard of sensitiveness adopted was very moderate we may mention that one of the instruments arranged as for the experiments was compared with a small magnetometer constructed by Prof. Boys, F. R. S. The latter instrument was found to be 160 times more sensitive than that employed in the observations just described.

* Paper read before the British Association, in Section A, Cardiff, August, 1891.

† We believe that some alterations have been made since the date of our experiments.

Priority in Alternating Current Motors.

Mr. Nikola Tesla, says the London *Electrical Engineer*, on Oct. 7, 1887, filed an application for patents in America, having already built and shown his machine in work and formed a company to exploit it some months before this. Mr. Tesla was run very close in claim for priority by Mr. Haselwander, whose machine, built in 1887, is now being shown at work at the Frankfort Exhibition. We have inquired of Messrs. Lahmeyer & Co., of Frankfort, who hold the Haselwander patents, as to the exact dates of the construction of this motor. They state that the first Haselwander rotary-current motor was constructed in the summer of 1887, and was set to work on Oct. 12, 1887. The first application for a patent for the said motor was made on July 21, 1888. As the patents were applied for by Tesla on Oct. 12, 1887, and were actually issued on May 1, 1888, 17 days before the publication in England of Prof. Ferraris' Italian paper on "Alternating Motors," and two months and a half before the date of Haselwander's patent, this would seem to settle the question, at any rate with the present data before us, in favor of Mr. Tesla.

Bell Telephones "for Export."

The advertisement and circulars of the Tropical American Telephone Company, Limited, which asserts that it has the exclusive right to sell Bell telephones "for export" to South America, Mexico and the West Indies, throw some light upon the actual cost of these telephones and the price for which they can be sold profitably.

It has been shown repeatedly that the Bell company exacts from local exchanges a rental of $14 per annum for the phone and transmitter, the patents on which die in January and March, 1893, the entire cost of which is $3.42, as admitted by officers of the company in testimony given before a committee of the Massachusetts Legislature. The price exacted by the local exchanges for telephone service in the large cities of the United States ranges from $100 to $150 per annum. The profits of the business have been enormous. The investigation made a few years ago by a committee of the New York Assembly gave to the people of New York some knowledge of the profits of the Bell company and its dependent local organizations, and of the manner in which the parent company had exacted from the local companies stock to the par value of more than $20,000,000, which was then held in its treasury.

One of the circulars of the exporting company to which we have referred set forth the "prices for export" of a complete outfit for a telephone line one mile long, with a station at each end. This outfit consists of two Bell telephones, two Blake transmitters, two magneto call bells, two backboards and battery boxes, two Leclanché battery cells to operate transmitters, two flexible cords to connect the telephone and call bells, one mile of No. 12 galvanized iron wire, 35 pony glass insulators with wooden brackets, 100 feet insulated office wire, spikes for brackets, staples for office wire, screws, etc. This circular, printed in English, says the price of the two sets of instruments is $80, subject to a discount of 55 to 60 per cent., and that the price of the "line outfit" is $13.25, subject also to a discount for large orders, so that the net selling price of the outfit of two Bell telephones, two Blake transmitters, two call bells, with backboards, battery cells and cords, as enumerated above, is only $32 to $36. On the circular notice is given in red ink, under the date Jan. 1, 1891, that "prices on complete sets, like cut" (which shows a Bell telephone, a Blake transmitter, a battery box, a backboard, cords, etc.) have been "reduced to $16.50 net cash." This would make the price of the two sets $33, instead of $36. To this sum may be added $13.25 for the "line outfit," the total being $46.25.

This should be interesting to subscribers in the United States who are paying from $100 to $150 per annum for the use of such instruments and the service connected therewith. It should be borne in mind that this price of $33 for two sets of instruments is a price for absolute sale, and not an annual rent. The buyer owns the property, which costs him only a little more than the rent exacted annually by the Bell company from the local exchanges simply for the use of such instruments, and is only one-third or one-

fourth of the rent paid annually by the subscribers in our large cities. The same company advertises that it has the exclusive right to sell in South America, Central America, Mexico and the West Indies, "Berliner's long distance transmitters and telephone sets, which it procures from manufacturers in Europe, thereby saving the heavy and burdensome United States royalties which have been hitherto paid for instruments manufactured under United States patents."

Those who use telephones in the United States will be surprised to learn that residents of the countries south of us can obtain a complete outfit, except the poles, for a private telephone line one mile long, with all the Bell instruments and appliances, for only $46.25, and by the payment of this sum can become the absolute owners of the property, with no rent or royalty to pay thereafter. But the circulars and advertisements of the company in question seem to show conclusively that such is the good fortune of our Southern neighbors. Undoubtedly there is a good profit in the business even at these prices, which appear very small when compared with sums exacted here by the Bell monopoly. The rentals for telephone exchange service in these South American countries range from $2.50 and $3 to $4 and $5 per month, a difference being made in favor of residences.

The Inventor of the Rotary Field System: Its Present Application and Future.*

BY LUDWIG GUTMANN.

Since the theory of the rotary field system has been argued at length, I wish to take up the practical side of it. I have chosen for my theme, "The Inventor of the Rotary Field System, and Its Present Application and the Future of It;" but I have concluded not to touch here the first part, which involves the question of priority. Later on I shall review the merits of previous inventors in the electrical periodicals.

Before entering upon the subject I should like to mention that I have chosen the expression rotary field and not rotary current, because similar ideas arose also in my mind as have been touched already by Prof. Hospitalier, of Paris, and because the characteristic part of the system is the rotary field. The currents are alternating currents, which are led around a mutual centre in succession, to the apparatus which is to be periodically excited. This mechanical arrangement of conveying power has most likely been the cause for that somewhat obscure expression, "rotary current." The properties attributed to the system are not peculiar to the current; they are peculiar to the rotary field, and these properties can certainly be shown as well on the combined wires as on the apparatus fed by them. Different articles published recently in the "Electrotechnische Zeitschrift," for instance, the one by Von Dolivo-Dobrowolsky (March 20, 1891), in which he says that the experiments made by Schallenberger and Tesla had not led to practical results, are apt to encourage unqualified and incorrect views and conclusions. On the contrary, the motors of Schallenberger are employed in his electric meter, of which at least from 8,000 to 10,000 are in daily use. These numbers alone might well speak against the just mentioned assertion (made by Dobrowolsky), and as to the Tesla motors, they have also come into use in a number of places. The sizes of these motors most employed are 5, 20 and 50 h. p.; they run assynchronously and are modified so that the momentum of rotation is the same in every position of the armature, consequently they are distinguished by smooth starting and uniform running. The average tension is 400 volts, and the number of periods per second is 60–70. I must remark, however, notwithstanding that, that the rotary field system has not spread in America, and for the following reasons:

At the time when the rotary field system, especially the generators and motors, was perfected, there were in existence in America about 250 central stations for alternating currents; they were partly in practical operation, and partly in process of construction. They worked with alternating current transformers which were fed by currents of 120–133 periods per second. This number of periods is for European ideas a very high one, but allows of the essential advantage of making small and light transformers with little copper and iron and of from 20 to 40 lamps capacity, which are the sizes mostly required in practice.

Let us now consider the commercial sides of the alternating current system and the rotary field system, which is necessary for a practical success. It is evident that the latter system will be more expensive for lighting stations than the former. To prove that, I need only to mention that the two-phase current transformers need two primary coils, of which each must have the same length as the one coil in the ordinary current transformer. In a similar proportion stand transformers which use more than two-phase currents for excitation. From this it is plainly seen that the material used in rotary field transformers produces hardly more than half the result of that used in alternating current transformers. It was simply due to commercial reasons that the rotary field system could not make greater progress in America in comparison with the alternating current system. However, the rotary field motor has received proper recognition. If notwithstanding this, as before mentioned, that motor has not been introduced generally for transmission of power it was for the reason that the motor could not be put on the two-wire circuits of the already existing central stations.

The American electricians always look for the simplest and cheapest system, and that is a two-wire system for alternating currents which can be used without distinction on the same circuit apparatus for lighting and heating purposes as well as for transmission of power. Such a system only will survive in the end, and by its general applicability it will lead to practical and favorable results. Such a system would enable the machines of many stations which are now idle most of the day to be employed, except for a few hours only.

In America the rotary field system has further experienced limitations in the field of transmission of power through the synchronous alternating current motor, but it has come into use in mines and similar places, where a motor with a commutator may cause explosions of gases.

The rotary field system may succeed better in Europe, and especially in Germany, than in America, where there are in existence at present probably over 500 alternating current stations, because it does not there meet its dangerous competitor. There exist in Germany, as far as I am informed, not over six high potential alternating current stations, and the rotary field system is already employed in Germany in the Lauffen-Frankfort plant. In Switzerland there are one or two stations. So much for the present. As we have enjoyed in America several years of experience with this system represented by the Telsa motors, I must oppose the assertion lately made by Herr von Dobrowolsky at a meeting of the Electrotechnische Gesellschaft held here in Frankfort. That gentleman said: "I believe I am able to assert that the motor problem for large and small works has been by this completely solved." This assertion goes most likely too far. The problem was already solved, theoretically and electrically, in 1889, but, as I showed you just now, the practical solution is strongly influenced by conditions of a strictly commercial nature, by competition and by the progress in technics. It must certainly be acknowledged that Herr von Dobrowolsky has done important work in the rotary field system. He has advanced considerably the art of transmitting power from great distances by his special and ingenious motors and construction of transformer. Notwithstanding this technics will not stop but progress steadily and suggest simpler means of accomplishing the result. Already the following competitors present themselves for use in large plants:

1. The synchronous alternating current motor with or without a transformer.

2. The alternating current-continuous current transformer and the continuous current motor.

For use in small works, that is factories and private plants, the motor alone may prove a success, but for central stations transformers will be necessary with the motors. Whether such a central station will pay must be taught by future experience, as a number of transformers will increase the price considerably and as rotary field motors require special stations and circuits without being able also to furnish light. A continuous current station will probably pay better. Outside of that there will be some new competitors (not yet known), which seem predestined for success and which hinder the general introduction of the rotary field system. In general it is a pretty dangerous task to describe the qualities of some not quite perfected machine. However, it is not my intention to describe the motors and work they will do, but I shall indicate here only the direction, the ways which were followed up. These new competitors are a few motor types which require only a two-wire system; they start with a maximal load and are in every respect in a far higher measure assynchronous than the rotary field motors. It is often said in our days that the plain, pure alternating current motor will not have a future because the exciter fields are not constant, and it is pointed out that it was reserved for the rotary field motor to fulfil these principal conditions; but it is not considered that the rotary field motor is a pure alternating current motor too in which a method is employed that gives a constant field in spite of the alternating currents used.

I should like now to make the assertion that if one such method is found several will likely be discovered which have nothing in common in principle.

Unluckily I am not authorized to speak about the construction of such motors, but the independence of the motors from their exciters is shown by the following: A motor was placed in a circuit of 130 periods per second, and its armature started a small dynamo that had a load of 30 lamps and was then running at a speed of 900 revolutions per minute. At a load of 50 lamps the speed of the motor armature dropped to 800 revolutions because it was overloaded. In another instance a motor was placed in a circuit of 70 periods per second; it ran without any load at a speed of about 200 revolutions per minute. Whether and to what extent these alternating current motors will fulfill the expectations entertained must be left to the future. The armatures of the synchronous alternating current motors and rotary field motors are in magnetic equilibrium with their fields, while those of the new motors just mentioned remain in magnetic instability with their exciter field. From these remarks may be concluded that in Europe, too, the success of the rotary field system will not depend solely on its own merits; it will—just as in America—be subject to the influence of circumstances and progress, and it may not realize the expected hopes in a few years.

Having now described the rotary field system in accordance with my own views, I will mention that, beside this problem, another one, still more important in my opinion, needs to have our attention here. I refer to the "problem of insulation." After Von Dobrowolsky and Brown have done such valuable work in the successful transmission of power from Lauffen to Frankfort, they would add a new leaf to their laurels, if, in addition, they would also determine the limits of the capacity of insulation on that plant and would communicate to us their results in all details. It seems to me that the ventilation of this question here is well justified, since it has acquired by ready aid on the part of the governments a general and, by calling the congress, an international character.

It would be most valuable to know to what potential the currents can be raised under all conditions of the atmosphere, when the modified form of Johnson Phillipp's insulators is employed, after the projected potential of 30,000 volts has been reached.

In conclusion I would like to add that although the fault I have mentioned arose in my mind regarding the general commercial success of the rotary field system, I willingly concede that Herr von Dobrowolsky alone, and in conjunction with Mr. Brown, of the Oerlikon Gesellschaft, has done most important work; both deserve well the fruits of their labor and I wish these courageous and untiring investigators the greatest success in these experiments, too.

NOTE—To explain my above named views, re Drehfeld, I would say: In Germany there exist three kinds of currents—continuous, alternating and rotary currents. I consider it dangerous to use the name "Drehstrom," or rotary currents; this latter name may be applicable to "eddy currents," and not for three or more separate alternating currents. We know there are in reality continuous, pulsating, alternating, intermittent and other currents which are modifications of the first three, but these would not give us the differences required. The differences are exhibited by the magnetic effects only. Here we must distinguish three totally different kinds—(1) Constant magnetic field, caused by a continuous or practically continuous current; (2) an alternating or intermittent magnetic field, caused by alternating or intermittent currents; and (3) a rotary magnetic field, caused by alternating or intermittent or alternating and intermittent currents applied in cyclical succession through several conductors. A rotary magnetic field can be obtained with two, three and more separate circuits and with as many different kinds of currents, and therefore either all should be called two phase, three or more phase currents, or, as proposed by Mr. Hoopskalter, multiphase currents, or else, if for three wires carrying alternating currents with different phase, a special name would be given. Each of the other forms would be entitled to the same privilege.

*Paper read at the Frankfort Electrical Congress.

Exhibitors at the Street Railway Convention.

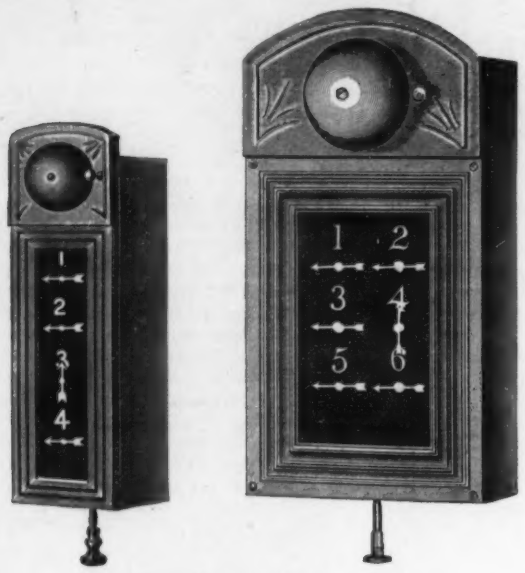
Judging from the number of applicants for space at the Pittsburgh convention the exhibition of street railway appliances will be the most complete that has ever been shown. Among the applicants are the following:

Adams and Westlake Company, Chicago, Ill.; Allen Paper Car Wheel Company, Chicago, Ill.; American Car Company, St. Louis, Mo.; Ball Engine Company, Erie, Pa.; Baltimore Car Wheel Works, Baltimore, Md.; Bodifield Belting Company, Cleveland, O.; Bridgeport Brass Company, Bridgeport, Conn.; J. G. Brill Company, Philadelphia, Pa.; Brownell Car Company, St. Louis, Mo.; Burton Electric Heater Company, Chicago, Ill.; E. L. Bushnell Spring Company, Poughkeepsie, N. Y.; Calorific Ventilating Heater Company, Chicago, Ill.; Cleveland Electrical Manufacturing Company, Cleveland, O.; Cushion Car Wheel Company, Indianapolis, Ind.; Duplex Street Railway Track Company, New York; Eastern Electrical Supply Company, Boston, Mass.; Edison General Electric Company, New York; Electric Construction Supply Company, New York; Electric Merchandise Company, Chicago, Ill.; Electrical Supply Company, Chicago, Ill.; Ellis Car Company, Amesbury, Mass.; Engineering Equipment Company, New York; Equitable Engineering Company. Philadelphia, Pa.; Falls Rivet and Machine Company, Cuyahoga Falls, O.; Fulton Foundry Company, Cleveland, O.; Graham, John H., Company, New York; Great Western Electric Supply Company, Chicago, Ill.; Griffin Car Wheel Company, Chicago, Ill.; Hathway & Robinson, Cleveland, O.; India Rubber and Gutta Percha Company, New York; Interior Conduit and Insulation Company, New York; Jewell Belting Company, Hartford, Conn.; J. K. & G. P. Insulating Company, New York; Johnson Company, Johnstown, Pa.; Johnson Safe Automatic Company, Richmond, Va.; Laclede Car Company, St. Louis, Mo.; Lewis & Fowler Manufacturing Company, Brooklyn, N. Y.; Lewis & Fowler Girder Rail Company, Brooklyn, N. Y.; Lieb Machine Works, New York; McGuire Manufacturing Company, Chicago, Ill.; Meaker Manufacturing Company, Chicago, Ill.; Michigan Stove Company, Detroit, Mich.; Morton Safety Heating Company, Baltimore, Md.; Munson, Chas., Belting Company, Chicago, Ill.; New Departure Bell Company, New York; New Process Raw Hide Company, Syracuse, N. Y.; New York Car Wheel Works, Buffalo, N. Y.; The R. D. Nuttall Company, Allegheny, Pa.; Okonite Company, New York; Peckham Wheel and Axle Company, Kingston, N. Y.; Pennsylvania Steel Company, Steelton, Pa.; Pierce Bros. & Co., Leominster, Mass.; Pomeroy & Fisher, New York; E. P. Preston & Co., Chicago, Ill.; Railway Register Company, New York; Robinson Machine Company, Bellwood, Pa.; Rochester Car Wheel Works, Rochester, N. Y.; Sawyer-Man Company, New York; L. A. Sayre, Chicago, Ill.; Chas. A. Schieren, New York; Schultz Belting Company, St. Louis, Mo.; Short Electric Railway Company, Cleveland, O.; Solar Carbon and Manufacturing Company, Pittsburgh, Pa.; Standard

Underground Cable Company, Pittsburgh, Pa.; Stanwood Manufacturing Company, Chicago, Ill.; Stephenson, John, Company, New York; Stiebel, Kissinger & Stiebel, Cincinnati, O.; St. Louis Car Company, St. Louis, Mo.; Thomson-Houston Electric Company, Boston, Mass.; Universal Electric Railway Construction Company, Philadelphia, Pa.; United States Steam and Street Railway Advertising Company, New York; Vacuum Oil Company, Rochester, N. Y.; Valentine Varnish Company, New York; Walker Manufacturing Company, Cleveland, O.; Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa.; John White, Allegheny, N. Y.; A. Whitney & Sons, Philadelphia, Pa.; Wightman Electric Manufacturing Company, Scranton, Pa.

The Hub Needle Annunciator.

The Electric Gas Lighting Company of Boston, owing to the demand for a cheaper annunciator than the ordinary gravity drop instrument and one that should be as perfect



The Hub Needle Annunciator.

in every way, is manufacturing and putting upon the market the "Hub" with the assurance that it meets the demand in every respect. A single magnet operates a gravity needle drop which is replaced by a mechanical set back. The drops are mounted on a metal base which cannot warp, shrink or throw the mechanism out of adjustment. It is small, has few parts to get out of order and these parts are readily accessible for repairs or adjustment. It requires a minimum of battery power and needs but very little attention. In fact it has proved to be just what is claimed for it—cheap, simple and durable.

A New Acid and Waterproof Socket.

The Bernstein Electric Company, of Boston, recognizing the necessity for an incandescent lamp socket for use in

An Acid and Waterproof Socket.

breweries, pulp mills, chemical works, marine installations, etc., that should be acid and waterproof, has brought out the one which we illustrate herewith, and which seems to cover these points completely.

The socket produced by the Bernstein company is composed of two hard rubber pieces compressed tightly between an upper and lower piece, and against the lamp collar. A rubber gasket at *A* prevents the entrance of acid fumes or moisture to the internal parts of the socket, which are composed of phosphor-bronze, while a second gasket at *B* compressed between the lower piece and the lamp cap serves as a check upon the first gasket, and protects the lamp collar. Okonite leading-in wires are sealed into the upper rubber part by a suitable composition. By the use of hard rubber the socket is given not only great strength and durability, but may be made in much more compact and graceful proportions than by using any other material, to say nothing of the perfect adaptability of rubber for the purpose for which the socket is intended.

Novelties in Incandescent Lamps.

Mr. J. L. Somoff, of No. 1 Ann street, New York City, is the manufacturer of some novelties in miniature incandescent lamps here illustrated. The lamps are useful at the present time, for there are new applications of electric light for miner's and firemen's lanterns, for surgical and dental operations, in a word, for purposes for which the old pear shaped lamp does not answer very well, if at all.

The little "pea," well known to everybody, is too big for such purposes as inspection of the bladder or stomach, and the "grain" lamp, Fig. 1, is just the thing that is wanted. The "tulip" lamp, Fig. 2, ready mounted, suits a surgeon better than the clumsy pear lamps, for the same holder or socket which fits an electro-cauterizing knife will hold a "tulip" lamp: and to replace one by the other is a matter of only a few seconds.

Then, again, in an electric lantern which is coming into use, the "bull's-eye" (Fig. 3) lamp takes the place of both the pear lamp and the concave curved lens, or bull's-eye, with which lanterns are usually equipped.

The "grain" is perhaps the smallest lamp that can

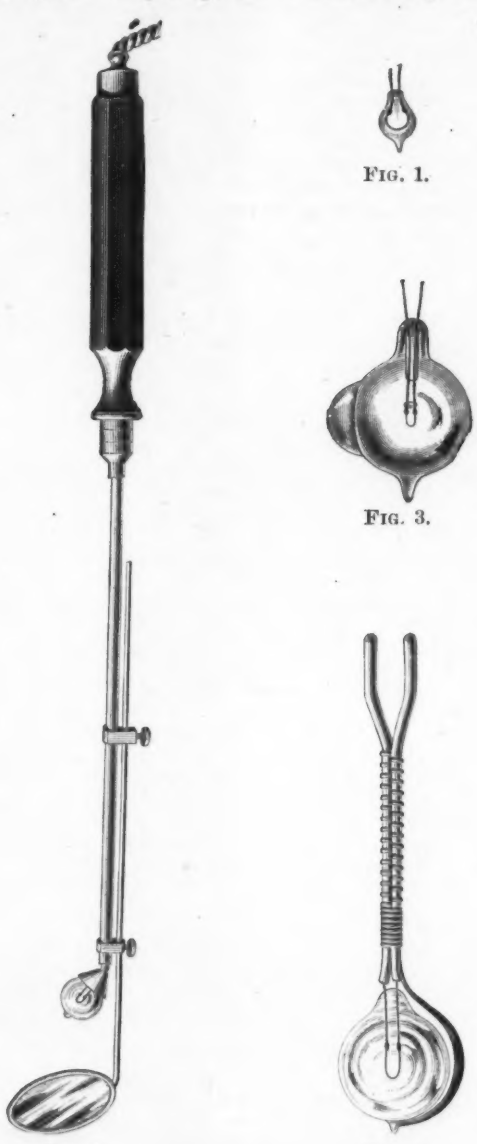


Fig. 1.

Fig. 3.

Fig. 4. Fig. 2.

Somoff's Incandescent Lamp Novelties.

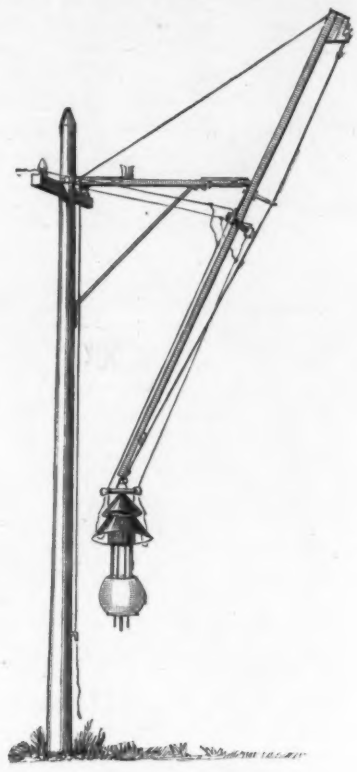
be made; its dimensions are three millimetres in diameter and five millimetres long. It is a 1 c. p. lamp, requiring from 3.5 to 12 volts pressure. The higher voltage is preferable when the lamp is intended for internal insertion into the stomach or bladder, for the small amount of current (.2 of an ampère) to bring to incandescence the very fine carbon filament would not heat up the globe to any more than the temperature of the human body.

Fig. 4 presents the same lamp mounted in a laryngoscope. This instrument, too, presents some novel features, for all metal parts are electro-plated with platinum, which effectively keeps the tool bright and clean and allows washing in water, diluted acid and all kinds of disinfectants without causing it injury.

The lower half of the lamp globe is incased in a platinum shell or cup, the metal being reduced upon the glass from the chloride compound at a red heat and united with the glass by fusion.

The Cliff Mast Arm.

The accompanying illustration shows the Cliff mast arm as manufactured and placed on the market by the Cliff Arm and Construction Company. The accompanying figure represents the mast arm as it appears in position after the lamp has been lowered for trimming. The company claims that this system of suspending lamps over the street is the neatest and cheapest method now in use. It is said that a man can trim one hundred double carbon lamps and make a circuit of ten miles very easily in seven hours. The trimmer carries with him a short rope, to the end of which is attached a snap hook, and upon reaching a lamp he snaps the hook into a ring which is fastened to the pole by means of a pin, and upon pulling out the pin he is ready to lower the lamp, which is a trifle heavier than the weight attached to the other end, so that by letting the rope run through his hand the lamp will come down to the pole where he stands. When it is trimmed he pulls down on the rope and fastens the ring in the pole by means of the pin which he has taken out, and he is ready to proceed to the next pole and lamp. The mast arms are so counterbalanced that it requires but little strength to operate them. The mast arm and bed piece are constructed of 4 by 4 spruce timber, and tapered from the end of the bed piece out. It is also strengthened by means of a guy

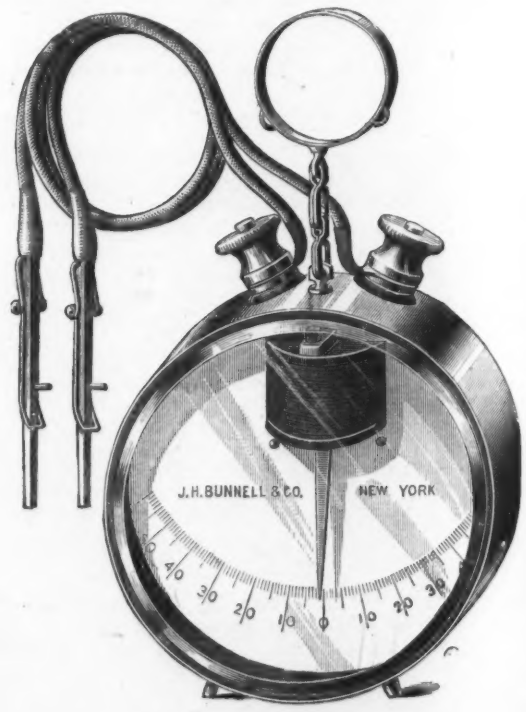


Cliff Mast Arm.

running from the end of the weight, and can be tightened when desired by screwing a nut attached to a screw eye running through the weight.

A Galvanometer Battery Gauge in Pocket Form.

This instrument, as made by J. H. Bunnell & Co., consists of a pocket galvanometer of such construction and calibration as to furnish a reliable standard for practical measurement of current strengths, in testing from one to five cells of ordinary batteries, such as the various forms of sal-ammoniac, sulphate of copper and acid batteries.



A Pocket Battery Gauge.

The reading is such that a good Leclanché cell indicates about 9 degrees; the Burnley dry battery, 14 degrees; the Lockwood American District (blue vitriol) batteries, 6 degrees; and the crowfoot Western Union form, 8 degrees.

As these gauges are all calibrated to a single standard and are made exactly alike, their introduction furnishes for comparisons, or condition tests of from one to five cells, an accurate instrument. The gauge being a true galvanometer and not dependent for its action on springs or electromagnetic devices, its indication is always the same for a given force.

The galvanometer gauge is arranged for use either stand-

ing upright on the instrument table or desk, or as when used for miscellaneous testing in the battery room, etc. It is held suspended by the chain and ring, in which position, without current, the needle hangs at zero, the same as it would if the galvanometer were standing on a table.

The galvanometer gauges are especially advantageous for use as permanent circuit indicators for fire alarms, burglar alarms, district telegraphs, etc., on account of their presenting the face of the instrument in an upright position.

For all the purposes for which it is available, one particular feature of its practical merit consists in the fact that the action of the needle is perfectly "dead beat," that is, the needle moves at once to whatever indication the current calls for and remains there without oscillation as long as the current continues.

Two silk covered conducting cords are attached to each gauge and these cords are provided with a very convenient form of improved tip, which is so made that it can enter any ordinary binding post and be held by the binding screw in the usual way, or, being a square end tip, is suitable for English binding posts, and also having a spring clamp it can be hooked firmly on to bare wire (office wire size or less) at any exposed point. This form of tip is extremely handy in all experimental temporary wire connecting, and by its use with the gauge the condition of any number of cells from one to five in the middle of a series can be instantly ascertained without making breaks and re-connecting.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

Chicago Quotations.—Col. S. G. Lynch, broker, 153 Monroe street, Chicago, furnishes quotations on telephone and electric light stocks as follows:

TELEPHONE STOCKS.

Chicago	$227@	$230	Cumberland	$60@	$62
Central Union	50@	51	Wisconsin	118@	120
Michigan	82@	83	Bell of Missouri	175@	180
Great Southern	30@	32	Iowa Union	20@	22
Colorado	34@	36	Missouri and Kansas	54@	56
Rocky Mountain Bell.	40@	43			

ELECTRIC LIGHT STOCKS.

Chicago Arc Light and Power	$97@	$99	Chicago Edison Co.	$145@	$150

NEW INCORPORATIONS.

The Crown Electric Company, of Chicago, Ill., has been incorporated, with a capital stock of $100,000, to manufacture and sell electric curative appliances. The promoters are Robert Greer, John Greer and Annie Greer.

The Cornwall Electric Lighting and Power Company, of Cornwall, N. Y., has been formed, with a capital stock of $15,000, to supply electricity for light and power. Thos. Taft, S. P. Young, H. W. Chadeyne, all of Cornwall, are the incorporators.

The Heat, Light and Power Company, of Chicago, Ill., has been incorporated, with a capital stock of $20,000,000, to supply heat, light and power. David E. Davis, Theo. Barratt, Wm. Barratt, Thos. Donald Mackay and Ernest Kauffman are the promoters.

The Pulaski Light and Water Company, of Pulaski, Va., has been organized, with a capital stock of $250,000, for the purpose of supplying electric lights, etc. J. H. Dingee, J. M. Wiegman, W. H. Triol, E. Graves and H. Alexander are the incorporators.

The Pulaski Electric Company, of Pulaski, Va., has been formed, with a capital stock of $25,000, to furnish electric light, heat and power. J. R. Miller, J. W. Lyons, R. E. Watson, R. B. Berkeley and G. L. Colgate are the promoters.

The Iron Cross Investment Company, of Basic City, Va., with a capital stock of $50,000, has been incorporated, to build street railroads, gas and electric works. W. V. Kirk, E. P. Cahill, J. W. Kirk, P. H. Gold, P. E. Stigers and C. H. Purcell are the incorporators.

The Buffalo, Kenmore and Tonawanda Electric Railway Company, of Buffalo, N. Y., has been incorporated, with a capital stock of $150,000, to operate a street surface railroad. The organizers are L. F. W. Arend, F. G. Sikes and G. H. Frost, all of Buffalo.

The Leslie Electric Light and Power Company, of Leslie, Mich., with a capital stock of $10,000, has been organized to supply the village of Leslie with light, power and heat. The promoters are J. A. Hanelly, V. H. Grant and A. A. Lumbard, all of Leslie, Mich.

The Chicago Electric Wire Company, of Chicago, Ill., has been incorporated with a capital stock of $1,000,000, to manufacture and deal in insulated wire and cables, electrical apparatus and supplies generally. J. W. Dyrenforth, C. N. White and J. N. Henson are the promoters.

Ogden Street Railway Company, of Chicago, Ill., has been incorporated with a capital stock of $2,000,000, to build and operate street railways to be operated by any motive power except steam locomotives. Houston C. Adcock, Nathan G. Mohre and Edward P. Towne are the incorporators.

The Egyptian Pottery Company, of Trenton, N. J., has been incorporated, with a capital stock of $14,000, to manufacture from the raw material sanitary ware and electrical supplies of all kinds, and sell the same. Chas. H. Baker, C. Turford, John Brindley and M. J. Carroll, of Trenton, are the incorporators.

The Pacific Coast Fuel and Gas Company, of Chicago, Ill., has been formed, with a capital stock of $5,000,000, to build, erect, operate and sell, etc., plants for furnishing gas and electricity for light, heat and power purposes. Levarth Annison, Calvin C. March, Luke T. Drury, Henry N. Miller and James Craig are the organizers.

The Columbus and Clintonville Electric Street Railway Company, of Columbus, O., has been organized, with a capital stock of $10,000, to build and operate an electric street railroad from Columbus to Clintonville, O. The incorporators are Jas. M. Loren, E. W. Pegg, C. M. Williams, John M. Wilson and W. H. Scott.

The St. Paul Electric Manufacturing and Construction Company, of St. Paul, Minn., has been incorporated with a capital stock of $100,000, to manufacture and sell commercial electricity, dynamos, motors, electrical supplies, etc. Paul Mattin, Jas. F. Hughes, and Chas. H. Lienan, of St. Paul, are the promoters.

The Athens Electric Light, Heat and Power Company, of Athens, Pa., has been incorporated, with a capital stock of $5,000, for supplying light, heat and power by means of electricity to the public at Athens. Howard Elmer Waverly, of New York, Wm. Stevenson and Wm. A. Stevenson, of Sayre, Pa., are the organizers.

The Suburban Electric Railway Company, of Bucyrus, Ohio, has been organized, with a capital stock of $200,000, to build a street railway to be operated by electricity or other motive power. W. C. Lemert, G. Donnenwrirth, C. W. Fisher, O. L. Hays, John Blyth, N. A. Sager, J. W. Gwynn and J. B. Gornly are the incorporators.

The American Engineering Company, of Jersey City, N. J., with a capital stock of $1,000,000, has been incorporated to design and construct steam and electric power stations and plants, equip railway lines, build underground conduits, manufacture machinery, etc. Granville T. Woods, of Jersey City, N. J.; J. S. Zerbe, C. C. Bowen and A. J. Zerbe, of Brooklyn, N. Y., and Henry Rein, of New York, are the organizers.

The Omaha Consolidated Electrical Company, of Omaha, Neb., has been incorporated, with a capital stock of $10,000, to establish, create and lease power, electric light and power circuits, and to sell, lease, operate and test electrical machinery, lights and power. H. A. Kinney, H. P. Kinney and Leavitt Burnham, of Omaha, are the promoters.

The People's Electric Light and Power Company, of Creston, Ia., has been formed, with a capital stock of $12,000, to furnish electric light and steam heat, and to erect an electric light plant in Creston. Markener Brothers, W. A. Tipton, F. A. Sparr, A. H. Sparr, Beecher & Miller, Lewis & Cole and S. A. Brewster, of Creston, Ia., are the incorporators.

The Lewis-Mercer Construction Company, of Jersey City, N. J., has been formed, with a capital stock of $200,000, to construct water works, sewers, gas and electric works and other works of public or private character by contract. Jared E. Lewis, John F. Zebley, both of New York City, and Harry B. Zebley, of Atlantic Highlands, N. J., are the incorporators.

Hammond, Ind.—The Northwestern Electric Motor Company, recently organized with a capital of $1,000,000, will erect a plant at Hammond for the manufacture of street car motors and storage batteries under the patents held by Theodore M. Foote, the inventor of the American rapid telegraph system and stock ticker. Ten acres of ground will be used for the plant.

The Williams Engine Company, of Baltimore, Md., has been incorporated with a capital stock of $50,000. The new company has purchased the business and good will of Samuel T. Williams, builder of the well known Williams automatic engine. Additional facilities will be added at once to the old plant, and the outlook for a large and increasing business is very promising.

The Edison Electric Light and Power Company, of Jersey City, N. J., has been incorporated, with a capital stock of $500,000, to construct, own, maintain and operate power stations and works for the manufacture, use, sale, etc., supply and distribution of electricity for light, heat and power. R. M. Jarvis, C. R. Van Dyke, D. E. Cleary, P. G. Van Zandt, B. A. Watson, Jas. Warner, J. D. Carscallen, F. J. Matthews, H. Lembeck, A. Q. Garretson, Wm. F. Abbett, all of Jersey City, are the promoters.

The Bates Electric Conduit Company, with a capital stock of $1,000,000, has filed articles of incorporation under the State laws of Iowa. The business of the incorporation is the manufacturing, owning, using, selling and disposing of conduits for the purpose of carrying or holding wires under ground, and for other electric purposes. The incorporators are C. H. Bates, W. A. Miller, Isaac McMichael, W. J. Marson and J. H. Weller. The principal place of business is Minneapolis. The company has sold the right to use its patent underground conduit in New York City for a large sum of money.

The Wheeler Condenser and Engineering Company has recently filed articles of incorporation with the Secretary of State at Trenton, N. J. The company has bought out the entire plant and business of the Colwell Iron Works, at Carteret, N. J., which is one of the largest concerns in this country manufacturing special machinery for sugar refineries, salt works and the like. The Wheeler company will continue to manufacture Wheeler's patent surface condensers and other of his specialties. The capital stock of the company is $300,000, and the incorporators are as follows: Fred'k Meriam Wheeler, of Montclair, N. J.; Aaron Vanderbilt, of New York City; Clifton H. Wheeler, of Brooklyn, N. Y.; William H. Hampton, of New York City, and Charles W. Wheeler, of Brooklyn, N. Y. The headquarters of the company will be at Nos. 92 and 94 Liberty street, New York City.

AFFAIRS OF THE COMPANIES.

The West Duluth Electric Company has amended its articles of incorporation so that the highest amount of indebtedness that may be incurred can be increased to $40,000.

The Merchants' Electric Light Company, of Leavenworth, Kan., has been organized for the purpose of constructing a plant and furnishing electric light to that city. The officers are as follows: C. M. Salinger, president; Carl Hoffman, vice-president; Herman Bruns, treasurer; J. H. E. Wiegant, secretary.

Dissolution of Partnership.—The copartnership heretofore existing between Theo. F. Taylor and Chas. G. Taylor, under the firm name of Taylor & Son, has been dissolved, and the business will hereafter be carried on by the Taylor Battery Company, with Theo. F. Taylor as general manager. The new company will commence business with a large number of orders on hand.

Millbury, Mass.—The Electric Light Company held its annual meeting last week. The officers elected are as follows: President, C. D. Morse; treasurer and general manager, P. W. Wood; clerk of the corporation, J. Henry Searles; directors, Thomas T. Robinson, A. S. Winter, H. M. Goddard, W. H. Lincoln. The meeting adjourned until two weeks from last night, as the treasurer and general manager's report was not quite ready.

A Receiver Appointed.—Thomas F. Stevenson has been appointed receiver for Stanley & Hall, manufacturers of electrical supplies at No. 34 Frankfort street. The business was started about ten years ago by E. W. Hazazer, who was joined by Arthur F. Stanley in October, 1886, and Harry Hall became a partner in March, 1890. The business was turned into a stock company in April, 1890, with a capital stock of $20,000, which was afterward increased to $30,000, the new stock being taken, it was said, by Sheldon H. Bassett, of Birmingham, Conn., who became vice-president. Royal A. Bassett, the latter's father, it is said, lent the company money which was secured by a chattel mortgage for $10,000 in August last. The receivership, it is said, is in the interest of Mr. Bassett. The company, it is reported, has about $12,000 unsecured debts, and there is due it about $14,000 from customers, besides stock on hand.

Reorganization of the Westinghouse Company.—It seems that the reorganization plan of the Westinghouse Electric and Manufacturing Company is now rapidly approaching completion. The committee, consisting of August Belmont, Brayton Ives and Charles Fairchild, has been diligently at work for several months, and matters have now been finally brought very near to a conclusion. This reorganization has been accomplished by the voluntary action of all the parties in interest, and is comprehensive and satisfactory. The committee has caused the accounts and affairs of the company to be very carefully examined, and the result is that the perfection of the plan will provide for the company's floating debt, and place it, by the absorption of the two minor companies, in a position to obliterate its fixed charges and greatly increase its assets and the compactness and economy of its organization. These changes have been accomplished without any increase of the company's capital stock. On the contrary, an amount of about $1,000,000 of stock will remain in the treasury to meet future wants of the business.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-177 TIMES BUILDING, NEW YORK, Oct. 12, 1891.

American Institute of Electrical Engineers.—The monthly meeting of the American Institute of Electrical Engineers has been postponed until Oct. 27, to avoid conflicting dates with the Street Railway Convention at Pittsburgh.

The Rollason Gas Engine Company has now in operation at its warerooms, 134 Liberty street, this city, 2, 4 and 12-h. p. gas engines. These are working very smoothly and efficiently and it is worth a trip to the warerooms to see them.

The Smith & Vaille Light Company, through J. M. Duncan, its New York manager, has sold a 750,000-gallon pump to the Milford Edison Company, of Milford, Delaware. The company has sold a 1,000,000-gallon pump for mining purposes to John Jerman, of Scranton, Pa.

The New Haven Insulated Wire Company has opened a New York office at room 308, No. 18 Cortlandt street, with Mr. H. G. Madden, formerly with the Empire City Electric Company, in charge. All communications sent to that address will receive prompt attention.

The Interior Conduit and Insulation Company will be represented at the Street Railway Convention held at Pittsburgh by Mr. E. H. Johnson, president, and E. T. Greenfield, electrician. The company will show its improved method of burying the feeder wires of electric railway systems, also its junction box.

Coming Tammany Leaders.—B. F. Hamilton, purchasing agent of the Sawyer-Man Company, is a Tammany delegate to the Tenth District Senatorial and county nominating conventions. F. W. Harrington, the New York agent of the Tropical American Telephone Company, is also a delegate to the Tenth Senatorial convention.

The Firm of Alexander, Barney & Chapin was one year old on Monday last (Oct. 5), and in honor of the day the store was profusely decorated and mottoes such as "The baby is one year old to-day; isn't he healthy and strong?" and others of equally suggestive character, called especial attention to the anniversary. Like every new business it has not all been smooth sailing since the start, but to-day the company is doing a large and lucrative business, is well liked by the trade, and everything points toward continued success and prosperity.

Mr. Harry Alexander, well known to the electrical fraternity through his connection with the Thomson-Houston Electric Company as well as other companies, and who went into business a short time ago, has found his business increasing to such an extent that he has taken a partner in Mr. Rufus N. Chamberlain and will do business under the firm name of the Alexander-Chamberlain Electric Company. Mr. Chamberlain has also had an extensive experience through his connection with the Sawyer-Man Electric Company and Julian Electric Traction Company. This new company intends to make a specialty of automatic isolated plants for private houses as well as inspection of all kinds of electric plants, but all kinds of electric work will receive prompt attention. Mr. Alexander and Mr. Chamberlain have both had considerable experience with storage batteries and propose to make the installation of commutator plants for light and power for launches as well as buildings a special feature. Electro-deposition will be made a specialty as well as electrical engineering and experimental work of all kinds.

L. H. H.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 28, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., Oct. 10, 1891.

Mr. Samuel A. Chase, of the Western Electric Company, was in town this week.

The Edison Electric Illuminating Company, of Boston, is to build a new station at 408 Atlantic avenue.

Derry, N. H.—Massachusetts parties have offered to build equip and operate the proposed electric railroad at Derry.

Peabody, Mass., has voted to erect its own lighting plant, and the necessary money has been appropriated to carry it through.

Messrs. A. L. Rohrer and W. H. Knight will represent the Thomson-Houston Electric Company at the Pittsburgh convention.

The Attica Electric Light and Power Company has purchased the property of the Thomson-Houston company at Attica, N. Y.

The Haverhill, Mass., newspapers are agitating the subject of using Mitchell's Falls for the generation of electric power and light.

The Germania Electric Company has decided to remove its works from Cambridge to Marlboro, and part of the machinery is now en route.

Middleboro, Mass.—A petition has been filed in the Supreme Court for the dissolution of the Middleboro Electric Lighting and Power Company.

The West End Railroad Company's new brick chimney rises 20 feet higher than Bunker Hill monument, and is one of the tallest chimneys in the world, being 252 feet in height, with a flue 14 feet in diameter, and having a capacity for 26,000 h.-p. in engines.

Lowell, Mass.—Ground has been broken for the new power house for the electric car railway. The building is to be 170 × 130 feet, and will contain five 500-h. p. engines. The plans are being made so that it can be easily increased with a warrantable increase of business.

Lawrence, Mass.—A petition has been signed by over 50 representatives of Ward Five asking the directors of the Merrimac

Valley Street Railway Company to extend the electric road through that ward. A great deal of interest is manifested in this extension in the westerly portion of the city.

Biddeford, Me.—The work of equipping the Biddeford and Saco Street Railway, so as to admit of the introduction of electricity has been commenced under the supervision of Mr. Kitson, recently of Worcester, Mass. The railroad company will attend to its own construction instead of placing the control with the electric company.

Messrs. Albert & J. M. Anderson were in receipt of a "cable" order a few days ago for "Boston" trolleys from London, Eng., which by the way was the third order from the same place, showing that they evidently appreciate a good thing and know they will get it when they order the "Boston." Messrs. Anderson report everything in the electrical line "booming."

Franklin, N. H.—The Gas and Electric Light Company of Franklin has just completed a contract with the Edison company to put in a forty-five arc light plant for them. The company has closed a contract with the town to light the village of Franklin Falls with thirty-three lights, to be run every night until midnight at a rate of $65 per light per year. The contract is for five years.

The Rapid Transit Commission is holding meetings nearly every day listening to complaints and various schemes for rapid transit that so many men wish to ventilate. The most comprehensive system is one of which a 30-page pamphlet with the necessary maps and drawings has been published, and which seems to cover the ground very thoroughly. This plan includes tunnel and open viaduct to be operated entirely by electricity.

The West End Street Railway Construction.—Although it will probably be two years before the electric system will be complete the extensions are being made as rapidly as possible. The Jamaica Plain line will be operated by electricity this week, using 30 cars. The belt line will follow in a few days. The company has in course of construction 273 long cars for the new lines. Twenty-five miles of track for these lines is being constructed at present.

Consolidated Pole Lines.—It is reported that there will be a consolidation upon a single line of poles of the following Boston companies: Postal Telegraph, New England Printing and Telegraph, Western Union, Boston Electric Light, New England Telegraph and the wires of the Fire Alarm service. This is not in any sense a commercial consolidation of the companies, but simply a union of their wires on the same line of poles for the convenience of the public and the improvement of the streets, thereby decreasing the great number of poles usually required for the service of so many companies.

The W. S. Hill Electric Company has been organized to manufacture the well known "Hill" specialties. Mr. Hill has associated with him in this new company Mr. George A. Denham, of the Merchants Bank, of Sioux Falls; George H. Poor, formerly general superintendent of the American Brake Company and late of the Boyer Railway Speed Recorder Company, of Chicago; George F. Gould, Judge of the Municipal Court, Portland, Me., and Louis F. Busiel, of Laconia, N. H. The above named together with W. S. Hill and Louis E. Hill will constitute the board of directors. The official roster is as follows: W. S. Hill, president; George A. Denham, treasurer; George H. Poor, general manager, with Louis E. Hill in charge of the manufacturing department. The offices of Mr. Denham and Mr. Poor will be at No. 54 Devonshire street. The factory will remain at No. 133 Oliver street, as at present, but the facilities will be very much increased by taking one or more extra floors. With the reputation for first class workmanship and material which Mr. Hill has established in the past in the manufacture of motors, dynamos, switches, arc lamp and switchboard apparatus and various other devices there can be no question as to the success of the new company.

C. A. B.

WESTERN NOTES.

Branch Office of The Electrical World,
465 The Rookery, Chicago, Oct. 10, 1891.

The Crocker-Wheeler Motor Company has one of its motors driving a Gould pump in the Chicago Exposition.

The N. Y. Safety Steam Power Company's Chicago office, No. 64 South Canal street, suffered somewhat from the late fire, but is transacting business as usual.

Peoria, Ill.—The experiment of racing by electric light has proved a great success at Lake View Park. The attendance one night was 3,000 and the races were very exciting.

Mr. W. A. Sheldon, general sales agent of the Schuyler Electric Company, is in Chicago looking after the interests of his company. Mr. Sheldon has secured several contracts for lighting plants during the last few weeks, the latest being at Niles, O.

The Borden & Selleck Company, of Chicago, sent a check for $50 to Fire Chief Swenie this week for the Firemen's Pension fund in recognition of the services of the department at the recent fire in the building adjoining the one this company occupies on Lake street.

Mr. Herbert Wadsworth, western manager of the Excelsior Electric Company, returned from St. Joe, Mo., this week with a check for nearly $20,000, in full settlement of the company's account with the city of St. Joseph, where 300 Excelsior lights are giving perfect satisfaction.

Amateur Electricians.—The Chicago Amateur Electrical Society has now a membership of forty. It has secured rooms at 120 Quincy street and at its third meeting, on the evening of Oct. 8, the members discussed the nature of the World's Fair display to be made by amateur electricians.

New Engines.—The Forest City (Ill.) Electric Light and Power Company has just placed in its plant two of the largest high speed engines in the city, and also two new No. 32 dynamos. The old ones were No. 16 dynamos, and the new ones will give them just double the amount of power.

The McLain Machine Company, of Canton, Ohio, has purchased the entire dynamo business of the Phœnix Electric Manufacturing Company, of Masillon, Ohio, and will manufacture the Bradley dynamo at Canton hereafter. Mr. James Bradley will be the superintendent of the electrical department.

The Borden & Selleck Company, 48 Lake street, Chicago, sustained a loss of $5,000, covered by insurance, through the recent burning of an adjoining building, but they are transacting business as usual, and can ship Harrison conveyors promptly to electric light or railway stations desiring to economize in the handling of their coal.

Mr. W. P. Martin, manager of the Globe Light and Heat Company, 52 Lake street, Chicago, was injured by pieces of falling glass during the fire that nearly wrecked his establishment recently, but is attending to business as usual, and has already made arrangements insuring prompt shipments of the companies electrical specialties.

Mr. Charles T. Van Depoele was in Chicago recently directing the installation of his mining drill and coal cutter in the exhibit of the Thomson-Houston Electric Company at the Chicago Exposition. The coal cutter was previously at work in one of the coal mines near Springfield, Ill. Mr. Van Depoele is always a welcome visitor in Chicago, his old home.

Kansas City Electric Line Sold.—The Ivanhoe Park electric line was sold at a foreclosure sale recently. The Thomson-Houston Electric Company, owner of $85,000 of the bonds, bought in the line for $25,000. The property consists of a single track, poles, and wire, running from Eighteenth street three miles south to Ivanhoe Park, and four electric cars.

Mr. J. W. Dickerson, editor of *Electricity*, is laid up with an attack of typhoid fever, and will probably not be able to resume work at his desk for five or six weeks. This will be sorry news for his many friends and the friends of *Electricity*. His place is being temporarily taken by Mr. Herbert Laws Webb, well known as an expert electrician and a clever writer on electrical subjects.

Engines for the Columbian Exposition.—Chief Robinson has made an important decision in reference to the size of the engines which may be placed in Machinery Hall in the double relation of exhibit and power plant. Engines from 500 to 1,000 h. p. will be admitted to this competition. The original statement was that engines of 150 h. p. would be received, but this has been changed.

Mr. Hugh Harrison, representing the Lieb Machine Works of New York, was in Chicago this week meeting old friends and talking up the merits of the Lieb specialties, many of which have been illustrated in The Electrical World. Mr. Harrison is meeting with fair success on the road, has secured several good orders, and will also be present at Pittsburgh to explain the practical points in Lieb's specialties to the street railway men who gather there.

Habirshaw wire will be used in the Leiter building, Chicago, and the first order for preliminary work includes 5,000 feet of No. 0000 B. & S., 5,000 feet of No. 2 B. & S., and 13,000 feet of No. 5 B. & S., all of the heavy Habirshaw insulation, and this order is but a sample of what the Electrical Supply Company, of Chicago, is receiving since it has so clearly demostrated the merits of Habirshaw insulation. The entire electrical work is in the hands of the Electrical Construction Company, of Chicago.

The Thomson-Houston Electric Company, through the Chicago office, has an exhibit in the Chicago Exposition consisting of a mining drill and a coal cutter operated by electricity, and several incandescent dynamos supplying current for lighting and for power service. Two of these dynamos are driven by duplex rotary engines, and the combination attracts considerable attention. From one of the dynamos current is supplied to 125 5-c. p. lamps placed at the street corners in a miniature village, and to 76 16-c. p. lamps that light this display at night. Mr. Thomas Fitzgerald, late of Detroit, is the electrician in charge of the lighting exhibit.

Sisson-Dean.—A pretty home wedding was solemnized at the residence of Mr. and Mrs. J. Z. Sisson, 3,241 Michigan avenue, Wednesday morning, at which Miss Mary E. Sisson and Dwight B. Dean were married. The ceremony was performed by the Rev. Dr. P. S. Henson. After the ceremony there was a reception and wedding breakfast. The interior of the house was prettily decorated with flowers and potted plants. Mr. and Mrs. Dean left at noon for an extended wedding trip in the East. On their return they will be at home on 45th street. Mr. Dean is the well known traveling representative of the Electric Merchandise Company, Chicago.

F. de L.

CANADIAN NOTES.

Partnership Dissolved.—The partnership existing between Theodore Belanger and Hormisdas Belanger, carrying on business as electricians, under the name of Belanger & Frère, Montreal, has been dissolved.

Electric Traction.—Alderman Prefontaine says that if the electric road on Bleury street, Montreal, is a success (and most people believe that it will be), other electric roads will be built, compassing the whole city and suburbs.

Lighting a University.—The work of introducing the electric light into Laval University, of Quebec, has been completed. An idea of its magnitude will be gathered from the statement that it took 70,000 feet of copper wire, and that 1,500 incandescent lights have been put into the building.

Electrical Separators.—Mr. S. J. Ritchie, of Akron, O., president of the Central Ontario Railway Company, has a proposition before the Trenton Council to establish electrical separators for the treatment of iron ores at an expenditure of $200,000, and asks the town for a bonus of $75,000. The industry, it is estimated, will give employment to a thousand men and two thousand more in the mines at Coe Hill and other points north. The proposal is favorably received.

The First Electric Road in Montreal.—Ald. Prefontaine says that the electric railway by-law will assuredly pass. "There will be modifications, of course," he said. "I am in favor of a clause to the effect that if, after twenty-four hours' notice, the company fails to give what is considered a fit and proper service by the Council, on complaint of a citizen, that the Road Committee have power to compel such service under severe penalties." He further said that he expected to see the new road kept open all winter. "I was speaking to the Ottawa Electric Railway people," he continued; "they expect to run all winter, and why not in Montreal."

Montreal Charges for Electric Light.—Mr. Louis Perrault appeared before the Corporation Committee to make application for a reduction in the charge for electric light supply. He thought that the Gazette Company and his own company should not be called upon to pay the same tax as the Royal Electric Company, which supplied so many more lights. They were all charged the same, $400 per annum, and he thought this unfair. The question gave rise to a long discussion, during which Alderman McBride stated that the Royal Electric Company could not produce the amount it had contracted for, and that there were at least a dozen companies now prepared to contract for supplying the city with the light it needed. Alderman Clendinning finally proposed to adopt a sliding scale for the charges made upon companies supplying electric light, the charge to be according to the number of lights supplied. This was unanimously carried.

ENGLISH NOTES.

London, Sept. 23, 1891.

Telephonic Trunk Wire Extensions.—Both the National Company and the Western Counties and South Wales Company, (the only large company in the United Kingdom which still maintains an independent existence), continue to add to their trunk wire net work. In the case of the Scotland district of the National Company this development is in the direction of adding wires to existing lines, which may be taken as a sign that intersuburban telephonic communication has found favor with the public there, and has proved profitable to the company concerned. The announcement of active competition with the National Company in London, which was made some few weeks ago by the Duke of Marlborough, still continues to attract considerable attention, and the opinion that the best way out of the difficulty lies in the intervention of the post office becomes more pronounced every day.

A New India Rubber Drying Process.—In a recent monograph on india rubber M. Ph. Rousseau criticises the chemical method of coagulation recently introduced on a large scale in Brazil. This process consists merely in mixing the india rubber juice with sulphuric and carbolic acids. The sulphuric acid coagulates something like 55 times its volume of gum and the carbolic acid acts as an antiseptic, improving the keeping qualities of the coagulated juice. Although this chemical process has the advantage over the method of smoking, of diminishing the portion of inferior rubber collected, the dust and vegetable dirt inherent to the old method being in a large measure avoided, M. Rousseau is nevertheless of opinion that the rubber treated in this way will prove less elastic and acid resisting. He argues that the molecular grouping of the rubber dried by the old evaporative process, by the smoke of fires, and by chemical action, must be very different and cannot but result in a marked change in the electrical, physical and chemical properties.

Answers to Correspondents.

Questions to be answered in this column must be of general electrical interest, and must be accompanied by real name and address as a guarantee of good faith. No notice will be taken of questions regarding apparatus unless enough details are given to permit a definite answer, and no dynamo or motor designing will be done.

Armature Winding.—I have an armature to wind for a 750-light Westinghouse alternator. The size of the wire is No. 12 B. & S. gauge 20 turns to each coil. What would be the result of using No. 13 wire and using 22 turns to the coil; would not the E. M. F. in the extra turns counterbalance the resistance of the smaller wire, and would it stand the load? W. K. H.

You had better use the original size of wire, as on general principles it is desirable to use as large wire in any armature as the construction permits so as to secure freedom from heating. The two extra turns of wire with the smaller size would more than counterbalance the resistance, and introduce a slight irregularity that would probably neither help nor harm you perceptibly.

Transformer and Dynamo Capacity.—(1) What constitutes the difference in transformers of small and large capacity aside from the size of the wire used? Is there not the same number of turns around the iron without regard to size? Is the capacity determined by the size of the wire alone. (2) In the construction of dynamos what determines the voltage and ampèrage that the machine will produce? H.

(1) In constructing transformers of different sizes the one thing that is kept nearly constant is the ratio between the number of primary and secondary turns, for this determines, other things being equal, the voltage. The size of wire in the windings varies from size to size; and the capacity is ultimately determined by the ability of the secondary wire to stand the current that is passed through it. The consequence of overloading a transformer is the same as that of overloading a dynamo. If the coils are not protected by a proper cut-out they will burn out or destroy the insulation. (2) The voltage of the dynamo is determined by three factors: the speed, the number of turns on the armature, and magnetic induction through the armature. The ampèrage the machine will give is simply limited by the ability of the armature wire to stand the heating which is necessarily produced when large currents are generated, in other words by the size of the armature conductor.

News of the Week.

THE TELEGRAPH.

Milwaukee, Wis.—The Western Union Telegraph Company will not be required to put its wires underground after all, the council judiciary committee having decided to accept the company's proposition to use aerial cables through alleys instead.

Reproduced Writing by Electricity.—An exhibition of telegraph writing was given Oct. 4 at the office of the American National Telegraph Company. A representative of the Telegraph Writing Company stood at a machine in St. Paul and wrote messages which were almost instantaneously reproduced in his own handwriting on a tape that rolled off a "ticker" at the Chicago end of the wire. Conversation in writing between several persons at both points were carried on for several hours and the test was considered thoroughly satisfactory.

THE TELEPHONE.

McKeesport, Pa.—The McKeesport Telephone Company will shortly open its lines in McKeesport. It will have about 200 patrons and will charge $3 per month for local service.

New York to Chicago.—It is reported that the representatives of the Bell Telephone Company in Washington say that the trunk line of 50 wires now being constructed between New York and Chicago will be completed in four months.

Racine, Wis.—The entire telephone system of Racine has been crippled so that 350 telephones are useless. The trouble was caused by an electric light wire falling on the telephone wires, burning off every wire in the central station. Not a telephone can be used, and it is not expected that the damage can be repaired before Oct. 15.

Tampa, Fla.—An exchange says that the telephone is put to a new use in a hotel at Tampa, Fla. Instead of an electric press button, every room will have a telephone connection with the office. Guests will be able not only to communicate with the office, but with their friends in other rooms at will. The great orchestrion, which was one of the marvels of the Paris Exposition, is to be placed in the music room of the hotel. It has been arranged that any guest in his room can, by merely telephoning to the office, be connected with the orchestrion and have the music transmitted to him in full volume.

THE ELECTRIC LIGHT.

Muncie, Ind.—The City Council has voted to establish an electric light plant.

Taunton, Mass.—The Hotel Bristol has introduced electric lights throughout the house.

Farmington, Mo.—The poles for the electric lights have been put in place, and Oct. 15 is the day set for the lights to be put in.

Quanah, Tex.—The city council of Quanah has granted an electric lighting franchise to capitalists from Fort Worth, and work on the plant has been commenced.

Scottdale, Pa.—The lighting of coal mines by electricity has proved a success at Leisenring No. 1, and the Frick Coke Company has decided to light all its shafts by the same means.

The California Electric Light Company, of San Francisco, Cal., are adding to their already immense power plant a 300-h

p. cross compound engine built by the Ball Engine Company, Erie, Pa.

Holyoke, Mass.—An 86-inch pulley, weighing over a ton, in the electric light station at Holyoke, burst last week and left the city in total darkness. Pieces of the pulley damaged the building and floors.

St. Paul.—The St. Paul *News* says that a company is soon to be incorporated in that city for the manufacture of electrical appliances, the factory to be located in the Sixth ward. The capital stock is to be $100,000.

Salem, Mass.—The committee of the City Council has been authorized to contract with the Salem Electric Lighting Company to furnish incandescent lamps for street lighting, not to exceed 250, at a cost not exceeding $23 per lamp for a year.

The Palace Hotel, San Francisco, Cal., has ordered a 200-h. p. cross compound engine from the Ball Engine Company, Erie, Pa., for their electric light plant. The Palace Hotel is now using a 100-h. p. tandem compound engine of the same make, with satisfaction.

Silver Bow, Mont.—The Silver Bow Electric Light Company will shortly enlarge its plant by the addition of much machinery. A 1,300-incandescent light dynamo, a 50-arc light machine and a 75-h. p. engine are to be added as soon as they can be secured. Two 100-h. p. boilers are also to be added.

Circleville, O.—The Circleville Electric Light and Power Company is to build an electric light plant in Circleville. The contract for the buildings has been awarded and work will be commenced at once. The buildings will cost about $15,000, and are to be erected near the present site of the gas works.

Du Bois, Pa.—Judge Krebs has handed down his decision in the case of the Du Bois Traction Railway Company *vs.* the Buffalo, Rochester & Pittsburgh Railway Company. The opinion gives the electric company the right to cross the tracks of the railway company by continuing the injunction against the latter.

Nashville, Tenn.—The citizens are preparing to put in an electric light plant, by which it is proposed to furnish electric lights to private parties at a cheaper rate than is now obtained. Operations will begin within a few weeks. The company has already put in an engine, and will put in a dynamo with a capacity of 2,000 lights.

St. Louis, Mo.—The Edison General Electric Company, through its agent, H. H. Humphrey, has secured contracts for placing a plant of 210 incandescent lights in the Central Distillery, one of 450 lights in the Pastime Club House, Vandeventer avenue and Morgan street, and one of 270 lights in the large works of the Beattie Manufacturing Company, Twenty-first and Pine streets.

Lander, Wyo.—Articles of incorporation have been filed with the Secretary of State incorporating the Lander Electric Light and Power Company. The capital stock is $10,000, divided into 100 shares of the par value of $100 each. The trustees for the first year are John D. Woodruff, Eugene Amoretti and Wm. A. Wallace. Besides lighting the town of Lander the power of the plant will be used for manufacturing purposes.

The American Electric Supply Company, of Buffalo, N. Y., through W. A. Fenn, general manager, has secured the contract for installing an electric light plant in the Erie County Savings Bank, of Buffalo. The plant will consist of 1,500 incandescent lights, the current for which will be generated by the use of Straight Line engines and C. & C. dynamos. Interior conduits will be used throughout the building.

Bushnell, Ill.—Messrs. Logsdon & Vandeveer, proprietors of the Bushnell electric light plant, have begun the erection of their power house. It will be of wood, metal covered, and will stand on the site of the old one. A 100-h. p. boiler will replace the 60-h. p. boiler that exploded. The same engine will be used. One of the dynamos needed only slight repairs, but the other dynamo is being pretty thoroughly overhauled. The delay in getting the site has put back the rebuilding, but without bad luck the lights will be going again by Oct. 20.

Waterloo, Ill.—The Electric Light and Power Company is making good progress with the installation of its plant, and expects to be ready for operation by Nov. 1. The work is in the hands of the Interstate Complete Electric Construction Company, of St. Louis, and the steam plant will be furnished and erected by the Pond Engineering Company, of the same city. The latter contract covers Armington & Sims engine, steel boiler, Lowe heater, Blake boiler feed pump, and Universal injector. The Heisler system of long distance incandescent lighting is to be used, and the plant is to be a model one in every respect.

The Portland Electric Light Company, of Connecticut, last week executed a 20-year lease of a tract of land on the Brainard Quarry Dump below the Air Line bridge as the site for its electric light station and the work of erecting it will be begun soon. The specifications prepared by George K. Hooper, engineer in charge, of the Germania Electric Company, call for a brick building with corrugated iron roof, 40 × 55 feet ground dimensions, walls 13 feet high and a brick fire wall through the centre 19 feet high. The engine and dynamo-room will be in the centre, 22 × 38 feet in size, with a 150-h. p. engine at the front and arc and incandescent dynamos, switchboard, etc., at the back.

Goshen, N. Y.—The board of directors of the Goshen Light and Power Company met at the Goshen Savings Bank on Monday evening of last week and elected the following officers: President, J. W. Corwin; vice-president, W. H. Wyker; secretary and treasurer, Dudley Murray; executive committee, J. W. Corwin, J. W. Gott, Joseph Merritt. It was decided at this meeting to proceed at once toward the purchase and erection of an electric plant, and 50 per cent. of the stock subscribed has been called for, payable to the treasurer at the savings bank on or before Oct. 8. It is expected that the company will have wires strung throughout the village and be ready to furnish electric lights by Dec. 1.

THE ELECTRIC RAILWAY.

Reading, Pa.—The Mayor of Reading has vetoed the ordinance permitting the use of the trolley system of electric cars in that city.

Braddock, Pa.—A special meeting of the Council was held last week to consider a petition from the Braddock Electric Street Railway Company for an extension of time from Oct. 1 to Nov. 10 to put their line in operation, and the extension was granted.

Hopkinsville, Ky., has granted a franchise to the Thomson-Houston Electric Company, of Cincinnati, O., to build an electric street car road through that city, and to erect an electric light plant. It is expected that the railway will be in operation by January.

Passaic, N. J.—The Bergen county Board of Freeholders has positively refused to permit the Paterson, Clifton and Passaic Electric Railroad to cross into Bergen county over the county bridge that connects the town of Garfield with Passaic. The fight has been a hard one and has lasted all summer.

Baltimore, Md.—The North Avenue Electric Railway Company has paid its first park tax, amounting to $1,165.65. This covered the period from the opening of the line for travel, May 1, 1890, to September 30, 1891. From the former date to June 30, 1891, the company's receipts amounted to $7,625.03, and from July 1 to September 30 they were $5,336.59, a total of $12,961.62.

Lockport, N. Y.—The Common Council of Lockport has granted a charter to the Lockport and Olcott Beach Electric Railroad Company for an electric road to the village of Olcott, under sixteen conditions. The principal of these are that the road shall be commenced within three months from the date of acceptance of the grant, and that it shall be completed by Aug. 1 of next year. The company is required to give a bond of $10,000, with four sureties, on or before Nov. 1, to comply with the conditions named.

From Buffalo to Williamsville, N. Y.—Capt. Robert F. Parsons, of the Buffalo & Williamsville Electric Railway, states that the company is now negotiating with construction companies for the building of the road. "Unless the weather should be very unfavorable," he said, "the road will be built this fall, provided the Buffalo Street Railway Company extends its line on Main street to the city limits. I understand that it is now putting up wires from the Erie tracks toward the city city, and consequently everything looks favorable for the early construction of our electric railroad."

Winthrop, Mass.—After long negotiations between the Boston and Revere Railway Company and the selectmen of Winthrop the final details were settled last week, and the license or franchise to build an electric railway in Winthrop were delivered to Mr. Washington G. Benedict, president of the Boston & Revere Railway. When the East Boston line is equipped with electricity, it will give Revere and Winthrop residents through electric service into Boston proper. It will require the building of some seven miles of track to complete the Boston & Revere Electric Railway system, and according to the terms of the franchise it is to be all finished and cars running by July 1, 1892.

GENERAL APPLICATIONS OF POWER.

Des Moines, Ia.—The Des Moines *Leader* prints the following item: "William Morrison and Louis Schmidt, of this city, have about completed an electric wagon to be used on the streets. They will run it by means of a storage battery and expect to have a strength of 10 h. p. If successful the gentlemen will make several of these vehicles. The first one will soon be exhibited on the streets."

Virginius, Colo.—The managers of the Virginius mine have added 60 per cent. to their electric power and are now running their concentrator, sawmill, great pumps, hoisting machinery and other appliances by that power, in addition to lighting the mine. Their original power was transmitted by two 00 wires, which they found insufficient. They have completed stringing and made the attachments of two 000 additional wires, thus giving them 76,000 feet of wire, as the distance from power-house to mine is 19,000 feet. For running the Revenue tunnel the power is applied direct. The Virginius Mine is at an altitude of 12,500 feet, and this new force in the mechanical world is the coming factor in operating large mines at high altitudes, where fuel cuts such an important figure in the aggregate outlay.

PERSONALS.

Capt. Eugene Griffin, of Boston, will deliver a lecture before the Franklin Institute Nov. 27 on "The Electric Transmission of Power."

Mr. E. I. Garfield, secretary of the Thomson-Houston company, started on a trip through the West last week, to be gone about a month.

Mr. E. H. Waldo, of Lynn, Mass., has been engaged as electrician for the Milford Electric Light and Power Company to succeed G. B. Coleman.

Mr. Nikola Tesla will deliver a lecture before the Franklin Institute on Feb. 15, 1892, on "An Experimental Study of Light Effects Produced by Alternating High Potentials."

Mr. E. W. Little, general manager of the Interior Conduit and Insulation Company, who has been very sick, is now improving. This will be good news to his many friends in the electrical field.

Mr. E. R. Mitchell, formerly employed at Lynn, Mass., by the Thomson-Houston Company, has gone to Minneapolis, Minn., to take charge of the repair department of the North Western Thomson-Houston Company, in that city.

Prof. Frank H. Bigelow, now assistant in the Nautical Almanac office at Washington, has been appointed to a newly created professorship in the Weather Bureau under Prof. Mark W. Harrington. He will give his entire time to the study of terrestrial magnetism and solar physics.

Mr. Charles Royal Binsmore, superintendent of the Marblehead (Mass.) Gas and Electric Company, died Sunday night at his home on Front street of typhoid fever, at the age of 29 years. Mr. Dinsmore had been in poor health for the last three months. He had resigned his position as superintendent of the gas works to take effect Oct. 15.

Mr. H. B. Prindle, for some time in charge of the Advertising Department of the Thomson-Houston Electric Company, Boston, has established the "Manufacturers' Advertising Agency" at room 732 Exchange Building, 53 State street, Boston. Besides doing a general advertising business, the company will open a new and valuable field, it having a separate department for the preparation of catalogues and price lists.

A Complimentary Resolution.—At the last meeting of the Executive Committee of the National Electric Light Association a very complimentary and deserved resolution was unanimously passed, thanking Mr. John Carroll, of the Eugene F. Phillips Electrical Works, of Montreal, Can., for his untiring and eminently successful labors in connection with the reception of the association during its convention at Montreal. These resolutions were ordered engrossed and presented to the above named gentleman.

MISCELLANEOUS NOTES.

Buffalo Electrical Society.—At a meeting of the society held Oct. 5, the reports of the officers which were read showed the society to be in a prosperous condition. The following officers were elected for the ensuing year: President, F. P. Jones; vice-president, Madison Buell; secretary, Astley C. Terry; treasurer, Samuel Stewart; librarian, Wm. C. Lewin; executive committee, the elected officers and Frank Kitton, Wm. H. Dopp and M. Beecher Marvin. A programme of papers and lectures to be presented before the society during the coming year is now in course of preparation.

Electrical Section of the Franklin Institute.—At the stated meeting, held Tuesday, Sept. 8, 1891, at the hall of the Franklin Institute, Prof. Edwin J. Houston, president, occupied the chair. Twenty members and visitors were present. Six nominations to membership were referred to the committee on admissions. Prof. E. J. Houston read a paper on "The Artificial Production of Rain." There was much discussion on this subject, and also on the queries from the question-box regarding the comparative intensity of the magnetic north and south poles of the earth, and the results obtainable in using Edelmann's electrometer as described in Ayrton's "Practical Electricity."

The Franklin Experimental Club, of Newark, held its first regular meeting since the summer vacation, on Tuesday evening, Sept. 29. There was a good attendance and there is every indication of an increased interest in the society and its work. The club is preparing to move into larger quarters, and with a view of increasing largely the growing membership it has decided to make the initiation fee for the next three months the small sum of five dollars. The dues are but one dollar and one dollar and a half per month for active and associate members respectively; and each member is entitled to the use of any and all apparatus, books, papers, use of room by day or night, and other privileges of the society. A large increase in the membership is confidently expected, as the organization has passed the crucial stage. Parties desiring further information may secure the same by addressing the secretary, Mr. F. W. Hillard, at 153 Mt. Pleasant avenue, Newark, N. J. After the regular meeting on Tuesday evening the members were entertained by some remarks by President Hammer upon the convention and exhibition of the National Electric Light Association at Montreal. Following this Prof. George C. Sonn gave some interesting and entertaining accounts of his summer tour in Europe, where he visited the electrical exhibition at Frankfort. He also described many things of scientific interest which he saw in the large cities of England, France, Germany, Switzerland, Holland, and elsewhere. His remarks were listened to with much interest. The society then adjourned to Oct. 13, at the rooms of the club. The meetings are held on the second and fourth Tuesdays in the month.

LEGAL NOTE.

Electric Companies Must Pay Taxes.—In the Supreme Court at Pittsburgh, Pa., last week a decision was handed down affirming Judge Simonton's decision in the suit between the Commonwealth and the Northern Electric Light and Power Company. Something over a year ago the electric light companies resolved to contest their liability to taxation, claiming to be exempt as manufacturing corporations. The case of the Northern Electric Light and Power Company was made a test case, a great many others depending upon it. Judge Simonton decided against the corporations and in favor of the State, holding that electricity was not a material substance, and could not therefore be considered a manufactured article. The companies appealed to the Supreme Court, but Judge Simonton's opinion has been fully sustained, and the companies will be compelled to pay the taxes.

Industrial and Trade Notes.

Mr. J. Edw. Wallace, of the Eastern Electric Supply Company, left for the South recently with a full line of railroad samples. He will return to Pittsburgh in time for the convention.

The Toronto Construction and Electrical Supply Company, Toronto, Canada, now handles a full line of Vulca ducts and appliances; also Grimshaw "White Core" and "B. D." wires.

W. F. B. Pratt, of No. 40 Cortlandt street, New York, agent of the Buckeye Electric Company, reports the sale of lamps constantly increasing, and, where once used, additional orders soon follow.

The Ball Engine Company, of Erie, Pa., shipped the Buffalo Street Railway Company a few days ago a 300-h. p. cross compound engine, being the fourth of the same size built by them for the Buffalo Street Railway Co.

J. W. Parker & Co., of Philadelphia, Pa., representatives of the Ball Engine Company, of Erie, Pa., are installing a 100-h. p. engine built by that company in the station of the Citizens' Electric Illuminating Company, Pittston, Pa.

Messrs. Clay, Pepper & Register, of Philadelphia, Pa., have been awarded the contract for the construction work of the Millville (N. J.) Electric Light and Power Company's plant. There will be 15 miles of Simplex wire used. The dynamos are to be Wood arc in conjunction with 60 municipal arc lamps, 40 commercial arcs and 40 Bernstein incandescent lamps, on the municipal circuits.

Messrs. Chas. A. Schieren & Co., of New York, report that the demand for their patent perforated electric belting is increasing, especially for use in electric railway work, because it can be run more slack than unperforated belting without slipping. No charge is made for the perforations. This company has just received an order from the Diamond Electric Company, of Philadelphia, for two 30-inch doubles, one 16-inch double, one 15-inch double, two 12-inch doubles, and four 11-inch double belts for its new power plant.

A New Catalogue.—The first edition of the remarkably convenient catalogue issued by the Illinois Electric MaterialCompany, of Chicago, being about exhausted Lieut. Hoefer is now at work on a revised copy that will find a welcome reception at the hands of every superintendent of a lighting or electric street railway station, the practical electrician and the buyer for electrical companies, for within a comparatively small compass will be found the name and price of every article required in light and power construction work, suitably arranged under separate headings and alphabetically indexed. In addition there will be some new tables and rules of convenience to all.

Compound Automatic Engines.—The Buckeye Engine Company, of Salem, Ohio, although building multiple cylinder engines since 1879, has never issued any description of them until the present time. The company is sending out "part third" of a descriptive catalogue of its engines. This section is modestly termed a circular; "the Progressive Engineer's Text Book" would not be out of place for a title, for it contains much valuable information covering the duty to be expected of compound automatic engines, both tandem and cross, condensing and non-condensing, the principles involved being explained so clearly that it will prove as interesting and instructive to the purchaser of an engine as to his engineer. Chapters covering the subject of "Cylinder Condensation," of the "Influence of Condenser and High Pressure," "Compound Diagrams," "Probable Steam Consumption," "Most Economical Cut-off," "Ratio of Work," "Clearance and Compression," "Quality of Steam," etc., form part of the contents of this valuable catalogue.

Handles for Tools.—Mr. E. L. Clark, secretary of the Illinois Electric Material Company, Chicago, while shipping a lot of construction tools, said that few contractors and construction companies appreciate the difference there is in the quality of the material from which are made the handles of telegraph shovels and spoons, carrying hooks, pike poles, raising forks, tamping bars, etc. Hickory is not as plentiful now as formerly, and many of the handles are made from rock or sugar maple which is peculiarly adapted for the rough service encountered in construction work, owing to its toughness and flexibility. The timber from which these handles are made comes from northern Michigan, and the best are made from split stock and are sawed or turned into the desired shape. That some

of the long handles are expensive is not to be wondered at, when it is remembered that but two or four perfect ones are all that can be secured from some trees, and that more than one-half the timber is ultimately rejected, that accepted being divided into two classes. A handle made from a perfect piece of timber will last for years with ordinary care. An imperfect handle, that is one in which the grain does not run straight, or other defects appear, is likely to snap the first time a heavy strain is placed upon it.

Atlanta, Ga.—The Consolidated Street Railway Company has consolidated under one management, with Joel Hart as president, the Gate City Street Railway Company, the West End and Atlanta Street Railway Company, the Atlanta and Edgewood Street Railway Company, the Fulton County Street Railroad Company and the Metropolitan Street Railroad Company. The lines of each will be extended, and the motive power of some changed to the electrical system.

Kansas City, Mo.—The Southwestern Electric Light and Water Power Company, of Kansas City, Mo., has gradually, under the able superintendence of Mr. C. E. Hart, worked up a very considerable water and lighting business. It is in the centre of the mining region, and a 100-h. p. generator is devoted exclusively to furnishing power for motors employed for mining purposes, the power being transmitted from two and one-half to three miles. It is expected that the company will do a considerable business in lighting mines. As the available horse power at its disposal is something like 2,000 h. p., there is opportunity for plenty of expansion, and the energy that has characterized the development of this business will doubtless be put to good use in loading the plant up to its full capacity. Fifteen hundred incandescent lights and 100 arcs are operated at Joplin, six miles from the power station. The plant itself is at Grand Falls, where work has been going on for about a year and a half getting ready for the large output expected from the station. The power equipment is intended to consist of four 500-h. p. turbines, one of which is now in place; the others will be added as the demand increases, probably, therefore, at an early date.

The Eastern Electrical Supply Company, of 65 Oliver street, Boston, will show a full line of electric railway supplies at the Street Railway Convention in Pittsburgh, and will be represented by M. W. Brown, president, and J. Edward Wallace, the manager of the railway department. Established a little over a year ago, the growth of this company has been remarkable. To-day they occupy a building comprised of five stories, employ 15 regular salesmen and supply all the leading roads of New England. They have just established a Chicago agency with offices in the Rookery and will be represented in the West by Mr. W. J. Pilicy. They are now at work on a new catalogue containing some 400 pages. An idea of what it will contain may be found by noting some of the new devices just being introduced by them, among which are the Emmet headlight, which is placed on the forward end of a car on the roof and which can be adjusted to any position desired throwing the light directly in front and the "B. G." coupler for tow cars, This company also carry a full line of the devices of the Electrical Specialty Company, of Pawtucket, which includes their pole step, line material and arc cut-out. The Eastern Company also have a new primary battery, which has a very large carbon surface, each one being treated separately.

An Important Factory.—While passing through Connecticut a few days since the writer took occasion to stop off at Milford and visit the works of the National Electrical Manufacturing Company, which have been enlarged and remodeled until now this plant is as complete as any in the country. One of the interesting devices shown was a cheap (in price only) fire alarm, designed to take the place of the more expensive Gamewell alarm, and which is now successfully working in Cleveland, Ohio, and other cities. The Elfenning indicator for hotels, by which a complete system of calls is obtained, is also about ready for the market and bids fair to be well received from the start. On the first main floor of the factory every style and variety of district box is manufactured, and with the advent of the new gear cutter, just in place, it is not now necessary to go outside of the factory to procure a single article that goes to make up these boxes, which are in demand not only in this country but in Europe. Next in order is wire, of which every variety of office, annunciator and magnet is made. Twenty-six braiding machines manufactured by the New England Butt Company (including one of their new magazine machines), and 50 special Splitdorff machines are constantly in operation, made necessary by the increased popularity of these goods. The main building, which is 290 feet long, contains at one end the offices of the company, which are located both on the upper and lower floors, while across the main floor is the power room, in which is a 60-h. p. Putnam engine. The company employs about 150 hands.

Business Notice.

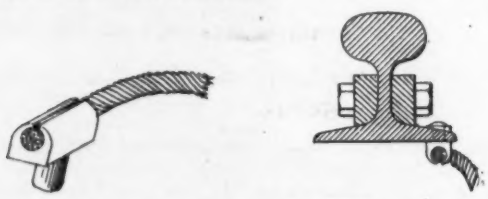
Big Reduction.—The price of the Brown & Sharpe No. 3 Universal cutter and reamer grinder is $200; former price, $260.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

U. S. PATENTS ISSUED OCT. 6, 1891.

460,571. Turnout or Switch for Trolley Wires; Daniel W. Edwards, of Saginaw, Mich., Assignor to the Murray Overhead Trolley Switch Company, of same place. Application filed Oct. 2, 1890. The combination, with the main and branch overhead wires of a trolley system for electric cars, of a turnout or switch forming the intersection of said branch wire with the main wire, said main wire led to each end of the switch or turnout at an acute angle to the main track of the car, and the branch wire led from the overhead switch or turnout parallel with the switch track of the car.

460,572. Printing Telegraph; Moses G. Farmer, of Eliot, Me. Application filed May 15, 1891. The combination, in a printing telegraph mechanism, with a primary battery, step-by-step mechanism adapted to reverse the current of the same, and keys for reversing the order of connections of any part or branch of the battery circuit controlled by the step-by-step mechanism, of a secondary line circuit in inductive relation to the primary circuit and a polarized magnet or relay therein for actuating the step-by-step mechanism. (See illustration.)



No. 460,615.—Rail Connection for Electric Railways.

460,587. Electric Arc Lamp; Hosea W. Libbey, of Boston, Mass. Application filed Jan. 12, 1891. In an arc lamp, the combination of the saddle for carrying the carbon holder, the saddle rod having a screw thread thereon, the upper end of said rod being square, the spiral disc carbon journaled in said saddle, the pencil carbon, and mechanism for operating the same to keep the carbons a suitable distance apart.

460,595. Arc Lamp Pencil; Isaiah L. Roberts, of Brooklyn, N. Y., Assignor to the Roberts-Brevoort Electric Company, Ltd., of New York. Application filed March 10, 1890. A pencil for arc lamps, composed of a metal associated with a substance containing chromium.

460,596. Electrode for Arc Lamps; Isaiah L. Roberts, of Brooklyn, N. Y. Application filed March 6, 1891. A pencil for arc lamps, composed essentially of carbon and a substance containing chromium, in combination with a metallic conductor or holder with which it is associated.

460,597. Electrode for Arc Lamps; Isaiah L. Roberts, of Brooklyn, N. Y. Application filed March 18, 1891. An arc lamp having as one electrode a pencil made up of a refractory substance which is a poor conductor associated with a conducting substance which may be either metal or carbon, and as the other electrode a pencil or its equivalent of carbon.

460,606. Electric Conductor; William Vogler, of Somerville, Mass. Application filed Nov. 9, 1889. An electric conductor consisting of two branches or wires, an independent semi-cylindrical insulation for each branch, and a re-enforcing strip interposed between said branches, upon the opposite sides of which the flat surface of the insulation rests, and an outer covering of insulation enveloping said branches, and re-enforcing strip to secure the parts in place.

460,607. Conduit for Electric Wires; William Vogler, of Somerville, Mass. Application filed Feb. 25, 1891. A conduit for electric wires or cables, the same consisting of a series of sections abutted together end to end and a series of surrounding shields held in place thereon by clamps.

460,614. Regulating the Speed of Electric Motors; Merle J. Wightman, of Scranton, Pa. Application filed Feb. 28, 1891. The method of regulating the speed of an electric motor run from a constant potential circuit, consisting in variably opposing the flow of current to the motor by coupling storage battery cells in the circuit leading through the motor from the supply wire in various combinations.

460,615. Rail Connection for Electric Railways; Merle J. Wightman, of Scranton, Pa. Application filed May 15, 1891. In an electric railway, a rail return divided into sections insulated from one another and provided with intermediate electric switches normally connecting said sections with one another, but each adapted to be turned at will to break the connection between adjacent sections of said rail return. (See illustration.)

460,618. Electric Switch; Charles Wirt, of Chicago, Ill., Assignor to the Electrical Supply Company, of Illinois. Application filed Jan. 10, 1891. In a circuit breaker, the combination of a central rotating portion with extended spring arms, contacts having faces concentric with such rotating part, and similar contacts having faces eccentric with reference to the centre of such rotating part and having faces exposed to such arms, one pair of such contacts being connected with the electrical circuit to be controlled.

460,619. Steno-Telegraphic Apparatus; Alexander Wood, of Philadelphia, Pa. Application filed Dec. 7, 1886. The combination of a battery at the transmitting end of the line, a group of independent circuits leading thence to the receiving end of the line, a group of keys controlling said independent circuits, a group of marker-magnets and a spacer-magnet at the receiving end of the line, a group of marking-arms and a spacing-arm in operative relation to said magnets, respectively, a recording ribbon arranged with relation to the marking-arms, spacing mechanism for advancing said ribbon longitudinally, said spacing mechanism being operatively connected with the spacer-arm, a group of relay circuits and relay magnets at the receiving end of the line arranged in operative relation with the main circuits for the marker-arms, armatures for said relay magnets, a pair of contact pieces operatively connected with each of said armatures and having different ranges of movement, one of each pair of contact pieces controlling a relay circuit of a marker-magnet, a spacer relay magnet and relaying circuit operatively connected with the main spacer circuit, and a group of circuits at the receiving end operatively connected with the spacer magnet and controlled, respectively, by a second member of each pair of said contact pieces, whereby when the spacer magnet is operated through the marker circuits the opening of the spacer circuit is delayed beyond the opening of the marker circuit.

460,634. Trolley-Wire Support; Thomas Fricker, of Ashtabula, O., Assignor of one-half to L. W. Smith and J. L. Smith, of same place, and Sarah A. Reed, of Erie, Pa. Application filed Dec. 15, 1890. In a clamp for a trolley and other supported wires, the combination of jaws, half-round screw-threaded shanks fitting together to form a bifurcated shank, and attaching means connected with said screw can.

460,650. Milliampere-Meter; Lyman D. McIntosh, of Chicago, Ill. Application filed Sept. 5, 1890. The combination, in a milliampere-meter, of a face-plate having on one side a short scale and on the opposite side a long scale, both scales arranged on the arc of a circle and both indicating milliampères of measurement, and a deflecting-needle, one end coacting with the short scale and the other end with the long scale.

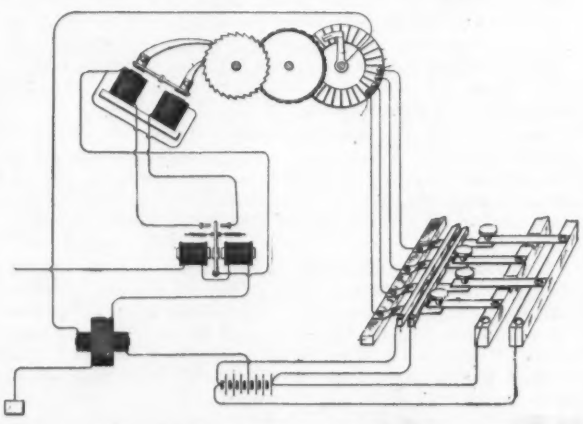
460,652. Globe Protector for Electric Arc Lamps; Edward J. Openlander, of St. Louis, Mo., Assignor of one-third to John C. King, of same place. Application filed March 14, 1891. In an electric lamp, the combination of the shade and the guard, said shade having the usual opening at its bottom to connect with the cup which supports the shades and carbons, said guard being dished in shape and having a central opening and resting upon the bottom of said shade, with its said central opening connecting directly with said shade opening.

460,676. Message Recording Instrument; Albert Storer, of Boston, Mass. Application filed Jan. 27, 1891. In a message recording instrument, the combination of the following instrumentalities: an actuating train, a starting magnet and its armature, a main and an auxiliary stopping device for said train, one of which is controlled by the armature and the other by the train in running, and a controlling device which causes or permits the main and auxiliary stopping devices to co-operate and stop the actuating train after the circuit has remained in its normal condition a longer time than the longest time that the circuit remains in its normal condition during the transmission of any signal.

460,680. Arc Lamp Electrode; Hosea W. Libbey, of Boston, Mass. Application filed Oct. 17, 1890. A carbon electrode for arc lamps, consisting of a hollow cylindrical carbon, the upper end of which is at right angles to its side and its lower end of spiral form.

460,695. Electrically Controlled Cutting Device; Le Roy S. White, of Waterbury, Conn., Assignor to himself and Samuel A. Chapman, of same place. Application filed Jan. 16, 1891. The combination with a cutter and a motor for operating the cutter, of a stop for arresting the motor, an electromagnet for withdrawing the stop, and an electric circuit in which said magnet is placed, the opening and closing of said circuit being under the control of the material to be cut.

460,701. Automatic Safety Cut-Out; William B. Cleveland, of Cleveland, O. Application filed June 8, 1891. The combination of a contact, a pivoted arm, and a switch-tongue engaging the contact and pivotally connected to said pivoted arm at a point a distance from the axial line of the fulcrum of the same.



No. 460,572.—Printing Telegraph.

460,725. Insulation for Electric Wires; John R. Markle, of Detroit, Mich. Application filed Nov. 24, 1890. An insulating base having scarfed end projections, a pair of wires extending longitudinally of said base and at some distance from each other, female contact plates located in the projecting scarfed end of the base and communicating with the parallel wires, and the male contact plates projecting from the shoulder of the opposite scarfed end of said base, said male contact plates having communication with the ends of the wires opposite the female contacts.

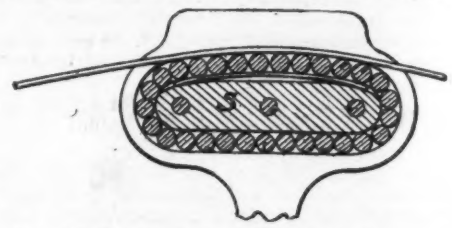
460,735. Trolley Wire Support; Nelson Weeks, Jr., of Long Island City, N. Y. Application filed April 1, 1891. The combination, with a line conductor, of a clip for clamping said conductor to leave an uninterrupted contact surface, and a suspending device having bearings for the clip, adapted to permit the free bodily movement of the conductor and its clip.

460,765. Composition for Insulating Material; Elihu Thomson, of Lynn, Mass., Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed Aug. 5, 1889. An electrical insulating composition consisting of a fibrous mineral insulator, as a base, a cementing insulating substance, such as rubber, and a lubricator consisting of an insulating material. (See illustration.)

460,548. Safety Plug; Henry Price Ball, of Brooklyn, Assignor to the Edison General Electric Company, of New York. Application filed Dec. 1, 1890. A holder for fusible conductors, consisting of a cup-shaped body supporting said conductors, a rim having lugs and notches below the lugs, and a cover supported below the lugs and normally closing the body, but movable to allow the escape of gas. (See illustration.)

460,767. Central Station Apparatus for Call Boxes; Edmund R. Wilder, of Kansas City, Mo. Application filed Jan. 2, 1891. In a central station apparatus for call boxes a registering mechanism, a metallic circuit from the box to the station, a register controlling device in such station, a starting battery at the central station, and a ground circuit from the station to the box, the metallic portion of which is the metallic connection from the box to the station, and which circuit includes the starting battery and a battery charger, whereby the starting battery is switched out after a momentary connection and a signaling battery switched in.

460,771. Telegraph Block System or Railway Traffic Control; David C. Coombes, of Lewisham, near Sydney, and William Roew, of Marrickville, near Sydney, New South Wales. Application filed June 19, 1891. In telegraph systems of railway control, the combination, with the operating device of the telegraph transmitter or block instrument, with insulated rails at either end of a block section, and with an additional or error signal, or make-and-break connections, electric fire alarms, electric batteries or generators in the signal boxes, and line-wire connections between the parts, all arranged and adapted to complete an electric circuit and give alarms on the entry of a train into a blocked section.



No. 460,781.—Electric Railway Trolley.

460,779. System of Electrical Signaling for Railroads; Simon De Jager and Albertus Zoutman, of Denver, Col. Application filed April 25, 1891. A signaling system for use on railroads, consisting of two interrupted conductors and one continuous conductor secured to the track and insulated from the ground, a battery or other source of electricity located on the train, one pole of the battery being electrically connected with both interrupted conductors and both poles with the continuous conductor, a rotary contact secured to the train and engaging the continuous conductor, said contact being divided into two parts insulated from each other, the line of division between these parts being such that the parts are alternately in contact with the conductor as the contact rotates, the poles of the battery being respectively and continuously in connection with said parts, whereby an interrupted current is established between trains upon the same track, and alarm mechanism located within the circuit.

460,780. Underground Railway Conduit; Emil E. Keller, of Chicago, Ill. Application filed April 13, 1891. In an underground electric railway conduit, an insulated conductor with a series of circuit closing devices connected therewith at intervals therealong, a series of movable conductors in the circuit, composed each of a heavy rail or the like substantially parallel with the conduit and suspended so as to move across such conduit, and connections between such movable conductors and circuit-closers, the heavy rails so constructed and disposed as normally to be in a position out of engagement with the insulated conductor and adapted when moved against its gravity across the conduit to bring its connection and the circuit closers together, so that each of such rails is successively pushed aside and placed in circuit by the trolley and is then permitted by gravity to be restored to its normal position out of circuit.

460,781. Electric Railway Trolley; Emil E. Keller, of Chicago, Ill. Application filed April 21, 1891. In a trolley the combination of a conductor body connected with the part to which the current is to be led and a series of rollers in contact with such body and disposed so that two or more of them will engage the conductor which delivers the current simultaneously. (See illustration.)

460,864. Automatic Electric Switch-Indicator; Everest W. Hadley, of Corvallis, Ore. Application filed Jan. 7, 1891. An automatic switch indicator having metal arcs located by the sides of the rails at a suitable distance from the entrance to a switch, their ends secured in non-conducting bearings and having connected to them the wires of an electric circuit, conductors or contact brushes mounted at the sides of an engine in insulated bearings, where they will come in contact with the arcs, an electric gong in the engine cab, in the station, and at the switch-stand, insulated wires adapted to connect said gongs, and the circuit opening and closing mechanism actuated by the switch staff.

460,887. Electric Railroad; Ira Robbins, of Sheffield, Ala. Application filed Jan. 19, 1891. The combination, with a continuous main conductor of a series of resilient or returning shunt wires connected electrically to the main conductor, and a drag connection for said wires arranged to be pulled along by the car and transmitting the electric current thereto from the main conductor.

460,895. Electrical Alarm; Homer P. Smith, of Neenah, Wis. Application filed March 24, 1891. A lubricant, having with an oil receptacle a depending tube open upon its sides, a movable buoyant contact guided upon the said tube, a spring actuated valve within the said tube, a fixed contact within the receptacle, the lower metallic portion having screw threaded upwardly extending portion to which the lower end of said tube is connected, and electrical connections.

460,926. Core for Electric Solenoids; John T. Williams, of Mount Vernon, Assignor to the International Portelectric Company, of New York. Application filed Dec. 18, 1890. The combination, with a coil of a magnetic core movable axially through the coil and composed of a series of members of different length and varying diameter, which are fitted one within the other in metallic contact.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N. Y.